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A MONOGRAPH

OF THE

BRITISH DESMIDIACEÆ

BY

THE LATE

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VOLUME V

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PREFACE TO VOL. V.

Eleven years have elapsed since the appearance of the fourth volume of this series, a period which has seen many changes, and during which the science of Algology has lost a number of its most active investigators. Undoubtedly the worst blow, as far as Britain is concerned, has been the irreparable loss of the two authors of the *British Desmidiaceæ*. In the death of his father, William West, in 1913, George S. West suffered the bereavement not only of a parent to whom he was devoted but also of a colleague who had been a fellow-worker and supporter since his early childhood when they pursued their algological studies together. From this blow he never quite recovered, for continued ill-health and the strenuous years of the Great War played havoc with his constitution, and finally, in 1919, he succumbed to pneumonia.

In attempting to complete, at the request of the Ray Society, this great work of her beloved and much-respected teacher, the writer is aware that she has undertaken a difficult task; yet she feels that, if only in publishing and thus rendering available for students of algæ the remainder of Professor West's beautiful drawings of Desmids, she will have accomplished something useful. Wherever possible the figures given have been copied from Professor West's drawings. Failing this, the drawings were made by the present writer in

most cases from material identified by Professor West; these are distinguished in the description of the plates by an asterisk. As a last resource the figures of previous authors have been copied.

Professor West's drawings and a list of British and foreign localities for Desmids were the only material left by the Wests on which the remainder of the work could be based. For inaccuracies in the diagnoses or remarks the writer must take entire responsibility. Whilst she has attempted to embody in these remarks all that has been previously published concerning the various species and, in addition, has sometimes included her own original observations, she can only regret that the information she is able to give is so meagre and incomplete in comparison with what it might have been if Dr. West had not prematurely died; for it is impossible that work resulting from a six or eight years' knowledge should form a worthy conclusion to that started on the basis of a life-long study.

Undoubtedly, many students when studying the numerous species of the difficult genus *Staurastrum*, will be especially disappointed at being deprived of the experience of our two great algologists. The arrangement into the main sections E, F, G, etc., adopted by the writer is, on the whole, the provisional one prepared by the Wests for the classification of the species of this genus and outlined by them in Vol. IV. A few alterations were made when the writer could not reconcile the structure of the species concerned with the characters of the group. These include the removal of *St. pungens* and *St. Simonyi* from Section E to Section F, *St. forficulatum* from Section I to Section J, and *St. aciculiferum* from Section J to Section I. The writer realises that the arrangement of the species within each

group is very unsatisfactory and that, when unusual forms of some species are in question, the keys will be useless; but she feels quite unable to make any improvement in these respects.

The localities of species, as given in the text, were compiled in the main by the two Wests, but a number of others have been added by the author from recent papers. The Canadian records were obtained from a hitherto unpublished list kindly sent by Mr. C. W. Lowe.

To the Department of Scientific and Industrial Research at London the writer is indebted for a grant which enabled her to spend an uninterrupted year at the work, and she is also indebted to Dr. G. T. Moore who allowed her to complete it during the tenure of a Fellowship at the Missouri Botanical Garden. To Professor Yapp, Dr. Jessie S. Bayliss-Elliott, and others in the University of Birmingham, and to all those who by their constant encouragement and interest have stimulated the continuation of the work, the writer is very grateful, and hereby expresses her warmest thanks.

NELLIE CARTER.

The Missouri Botanical Garden;
August, 1922.

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BRITISH DESMIDIACEÆ.

Genus 18. **STAURASTRUM** (*continued*).

Section E.

Cells furnished with spines at the angles only, each angle provided with single or binate spines, rarely with three or four.

* Cells having a single spine at each angle.

† Cell-wall smooth or minutely punctulate, never granulate or verrucose.

42. *St. glabrum.*
43. *St. Dickiei.*
44. *St. apiculatum.*
45. *St. dejectum.*
46. *St. mucronatum.*
47. *St. O'Mearii.*
48. *St. pterosporum.*
49. *St. connatum.*
50. *St. jaculiferum.*
51. *St. curvatum.*
52. *St. megacanthum*
53. *St. aristiferum.*
54. *St. cuspidatum.*
55. *St. pseudocuspidatum.*
56. *St. leptodermum.*

†† Cell-wall granulate or even verrucose.

57. *St. Ungeri.*
58. *St. tunguscanum.*
59. *St. lunatum.*
60. *St. cornutum.*
61. *St. Gatniense.*

** Cells with more than one spine at each angle.

† Cell-wall smooth or punctulate, never granulate.

62. *St. bifidum.*
63. *St. longispinum.*
64. *St. Brasiliense.*
65. *St. quadrangulare.*
66. *St. quadrispinatum.*

†† Cell-wall rough with tiny granules.

67. *St. denticulatum.*
68. *St. Avicula.*
69. *St. subcruciatum.*
60. *St. cornutum.*

42. **Staurastrum glabrum** (Ehr.) Ralfs.

(Pl. CXXIX, figs. 2–5.)

Desmidium glabrum Ehr. Meteorpap. 1838, pp. 51 and 56, t. 1, f. 13 (in part).
Phycastrum glabrum Kütz. Phyc. Germ. 1845, p. 137; Spec. Alg. 1849, p. 179.
Staurastrum glabrum Ralfs, Brit. Desm. 1848, p. 217; Arch. in Pritch. Inf. 1861, p. 738; Cooke, Brit. Desm. 1887, p. 143, t. 50, f. 4; De Toni, Syll. Alg. 1889, p. 1145; Roy, Freshw. Alg. Enbridge Lake and Vicin. 1890, p. 337; Roy & Biss. Scott. Desm. 1893, p. 20; West & G. S. West, Some N. Amer. Desm. 1896, p. 255, t. 16, f. 8 (var.); Alg. N. Ireland, 1902, p. 44; Borge, Botan. Notiser, 1913, p. 28.
Phycastrum (Stenactinium) glabrum Näg. Gatt. einz. Alg. 1849, p. 128.
Staurastrum dejectum β Debaryanum forma Borge, Sverig. Chlorophyc. II, 1895, p. 23, t. 1, f. 14.

Cells very small, about as long as broad, not including the spines, or sometimes a little broader than long, deeply constricted, sinus widely open and almost rectangular; semicells in front view cuneate, sides straight or very slightly convex, apex straight or slightly concave, with a long, strongly inflexed spine at each angle. Vertical view usually triangular, sides slightly concave, angles ending in a sharp spine. Chloroplasts axile, one in each semicell, with a central pyrenoid, and a pair of lobes extending into each angle.

Zygospore "globular, spines numerous, simple, subulate, base broad" (*Roy*).

Length 16–25 μ; breadth, without spines, 15–30 μ; length of spines 7–10 μ; breadth of isthmus 5–7 μ; diam. zygosp., without spines, 25·6 μ; length of spines 14·4 μ.

England.—Cam Fell and bog near Clapham, W. Yorks! Mickle Fell, N. Yorks! Bisley Common, Surrey! Enbridge Lake, Hants (*Roy*). Devon! (*Harris*). Cornwall (*Marquand*).

Wales.—Moel Siabod, Llyn Bochlwyd, Glyder Fach

(at 2,200 ft.), Llyn-y-cwm-ffynon and Capel Curig, Carnarvonshire!

Scotland.—Common (*Roy & Biss.*). Rhiconich, Sutherland! Shetlands!

Ireland.—Lough Nacung, Donegal! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—Germany. Austria. Sweden. Asia Minor. United States (var.).

St. glabrum is a widely distributed but rarely abundant bog species, whose angular form and inflexed spines readily distinguish it from all allied species.

43. **Staurastrum Dickiei** Ralfs.

(Pl. CXXIX, figs. 14, 15.)

Staurastrum Dickiei Ralfs, Brit. Desm. 1848, p. 123, t. 21, f. 3; Arch. in Pritch. Inf. 1861, p. 737; Rabenh. Krypt. Fl. Sachs. 1863, p. 189; Gay, Monogr. loc. Conj. 1884, p. 67; Wolle, Desm. U.S. 1884, p. 122, t. 40, f. 5, 6, t. 51, f. 20, 21; Cooke, Brit. Desm. 1887, p. 140, t. 49, f. 3; Wittr. & Nordst. Alg. Exsic. Fasc. 21, p. 37, 1889 (forma); De Toni, Syll. Alg. 1889, p. 1139; Anderss. Sverig. Chlor. 1890, p. 11; West, Alg. W. Ireland, 1892, p. 171; Alg. aq. dulc. Lusit. 1892, p. 1503 (forma); Lütkem. Desm. Central China, 1900, p. 123, t. 6, f. 28, 29 (forma); Comère, Desm. France, 1901, p. 162, t. 13, f. 23; Schröder, Gallertbild. Alg. 1902, p. 168, t. 7, f. 18; G. S. West, Brit. Freshw. Alg. 1904, p. 141, f. 52, A–C; Borge, Süssw. Alg. Spitzb. 1911, p. 19.

Didymidium (Staurastrum) convergens B *trigona* Reinsch, Algenfl. Frank. 1867, p. 154.

Staurastrum brevispinum β Dickiei Rabenh. Flor. Europ. Alg. 1868, p. 202.

St. dejectum β Dickiei Jacobs. Desm. Danem. 1875, p. 204.

St. laniatum Delp. Desm. subalp. 1877, p. 135, t. 10, f. 17 (in part).

St. forcipatum Playfair, New or less-known Desm. N. S. Wales, 1907, p. 182, t. 5, f. 1.

Cells rather small, about as long as broad, not including the spines, deeply constricted, sinus open and acute-angled with a slightly rounded apex; semicells subelliptic in outline, dorsal and ventral margins almost equally convex, or the ventral margin a little more convex than the dorsal; angles terminating in a short, very slightly recurved spine, directed towards the other semicell. Vertical view triangular, lateral margins somewhat concave, angles rather inflated, each with a short spine. Chloroplasts one in each semicell, with a

central pyrenoid and a pair of lobes extending into each angle.

Zygospore globose, covered with numerous long spines, broader at the base.

Length = breadth (not including the spines) = 34–44 μ; length of spines 4–5 μ; breadth of isthmus 5–7 μ; diam. zygosp., without spines, 39 μ; length of spines 11 μ.

ENGLAND.—Cumberland! Westmoreland (*Biss.*)! Lancashire! W., N., and E. Yorks! Leicestershire (*Roy*). King's Norton, Worcs! Surrey (zygospores from Puttenham Common)! Hants; zygospores from New Forest (*Roy*)! Kent! Devon (*Harris*). Cornwall (*Marquand*)!

WALES.—Moel Siabod, bog between Glyder Fach and Llugwy, Llyn Idwal, Llyn Padarn and Capel Curig, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—General; zygospores from Aberdeen and Kincardine (*Roy & Biss.*). Near Lochmaddy, N. Uist and in Lewis, Outer Hebrides! Shetlands! In the plankton!

IRELAND.—Donegal! Mayo! Galway! Plankton of Lough Caragh, Kerry! Dublin and Wicklow (*Arch.*). Armagh! Down!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Hungary. Servia. Portugal. Norway. Sweden. Denmark. Bornholm. Finland. Poland. N. Russia. Faeroes. Nova Zembla. Spitzbergen. Greenland. Siberia. Central China. Japan. E. India. Australia. New Zealand (var.). Madagascar (var.). Central Africa. United States. Brazil. Paraguay. Patagonia.

St. Dickiei is a most ubiquitous Desmid and frequently occurs in great abundance in gatherings from bogs and marshes. It is only very rarely found in plankton. By reason of its broadly elliptical semicells, and slightly inflexed spines, it is a species which is very easily recognised.

Forma **punctata** West.

St. Dickiei forma *punctata* West, Alg. W. Ireland, 1892, p. 18; Clare Island Alg. 1912, p. 21.

A form with the cell-wall minutely punctate ; in all other respects quite similar to the type.

England.—Bowness, Westmoreland ! Thursley Common, Surrey !

Ireland.—Near Westport, Mayo ! Clifden and Ballynahinch, Galway ! Adrigole, Cork !

Var. **circulare** Turn. (Pl. CXXIX, fig. 16.)

St. Dickiei var. *circulare* Turn. Freshw. Alg. E. India, 1893, p. 105, t. 16, f. 5 ; West & G. S. West, Some N. Amer. Desm. 1896, p. 255.
St. Dickiei var. *semicirculare* West & G. S. West, Alg. S. England, 1897, p. 492.
St. brevispinum Hustedt, Desm. Bac. Tirol, 1911, p. 338, f. 28.

Cells nearly circular in outline, not quite so deeply constricted as in the type ; semicells nearly semicircular, sinus linear in the median part, finally opening more widely. Spines straight and considerably shorter than in the type, very strongly inflexed, and attached at the basal angles of the semicell.

Length 24–40 μ ; breadth 26–40 μ ; breadth of isthmus 8–12 μ ; length of spines 2–3 μ.

England.—Thursley Common, Surrey !

Geogr. Distribution.—Poland. India. Central Africa. United States.

This variety is well defined from the type by reason of its semicells with very strongly convex apex and short, straight, and strongly inflexed spines, which project from the basal angles of the semicell.

Var. **rhomboideum** West & G. S. West. (Pl. CXXIX, fig. 17.)

St. Dickiei var. *rhomboideum* West & G. S. West, Scott. Freshw. Plankt. I, 1903, p. 545, t. 16, f. 9.

Semicells distinctly rhomboidal in shape ; spines rather longer, and strongly incurved.

Length 37 μ ; breadth, without spines, 38·5–46 μ ; length of spines 6–9·5 μ ; breadth of isthmus 8·5 μ.

Scotland.—Plankton of Loch nan Eun, N. Uist, Outer Hebrides !

44. **Staurastrum apiculatum** Bréb.

(Pl. CXXIX, figs. 6–8.)

Staurastrum apiculatum Bréb. Liste Desm. 1856, p. 142, t. 1, f. 23; Arch. in Pritch. Inf. 1861, p. 737; in Q. J. M. S. 1868, p. 67; Cooke, Brit. Desm. 1887, p. 139, t. 49, f. 2; Borge, Süssw. Chlor. Archang. 1894, p. 37; Roy & Biss. Scott. Desm. 1893, p. 16; West & G. S. West, Some N. Amer. Desm. 1896, p. 254, t. 16, f. 6; Freshw. Chlor. Koh Chang, 1901, p. 92; Alg. Yorks. 1902, p. 96; Alg. N. Ireland, 1902, p. 44; Georgev. Desm. Macedonia, 1910, p. 243; Borge, Botan. Notiser, 1913, p. 28.

St. dejectum var. *apiculatum* Lund. Desm. Suec. 1871, p. 59; Kirchn. Alg. Schles. 1878, p. 169; Wille, Norges Ferskv. Alg. 1880, p. 40; Comère, Desm. de France, 1901, p. 161, t. 12, f. 30; Hirn, Desm. Finnland, 1903, p. 20, t. 2, f. 30.

St. dejectum α Jacobs. Desm. Danem. 1875, p. 203.

Cells small, about as long as broad, deeply constricted, sinus widely open, with its apex acutely rounded; semicells rather wine-glass shaped, dorsal margin almost straight, only slightly convex, or even a little concave, ventral margin nearly semicircular; with a minute acute spine at each angle which is dorsal rather than lateral in its attachment, and is directed vertically upwards. Vertical view triangular, lateral margins slightly concave, angles somewhat turgid and provided with a minute mucro at each extremity.

Zygospore spherical, provided with numerous simple acute spines.

Length = breadth = 18–29 μ; breadth of isthmus 5·5–7 μ; diam. zygosp., without spines, 23 μ; length of spines 6 μ.

England.—Cumberland! Westmoreland (*Biss.*)! W., N., and E. Yorks! Cambridge! Surrey (zygospores from Thursley Common)! Hants (*Roy*)! Devon (*Harris*). Cornwall (*Marquand*)!

Wales.—Not uncommon!

Scotland.—General, but scarce! With zygospores from Slewdrum, Aberdeen (*Roy & Biss.*).

Ireland.—Donegal! Mayo and Clare Island! Galway! Kerry! Dublin and Wicklow (*Arch.*). Louth! Down! Londonderry! Plankton of Lough Neagh! of Galway! and of Kerry!

Geogr. Distribution.—France. Germany. Galicia in

Austria. Turkey in Europe. Norway. Sweden. Denmark. Finland. N. Russia. W. Greenland. Japan. Burma. Siam. Australia. United States.

St. apiculatum is very closely allied to *St. dejectum*, *St. mucronatum* and others, but is readily distinguished from all similar forms by the shape of its semicells, with their nearly straight apices and minute spines projecting vertically upwards. It is quite a common species and is widely distributed.

The original description of the zygospore given by de Brébisson and copied by Cooke and others is inaccurate, since the zygospores have numerous sharp spines, not blunt ones with broad bases.

45. **Staurastrum dejectum** Bréb.

(Pl. CXXIX, figs. 9–12.)

Binatella dejecta Bréb. Alg. Falaise, 1835, p. 269.
Staurastrum dejectum Bréb. in Menegh. Synops. Desm. 1840, p. 227; Ralfs, Brit. Desm. 1848, p. 121, t. 20, f. 5 (ex parte); Bréb. Liste Desm. 1856, p. 142; De Bary, Conj. 1858, p. 50, t. 6, f. 25–32; Arch. in Pritch. Inf. 1861, p. 737; Rabenh. Krypt. Fl. Sachs. 1863, p. 189; Wood, Freshw. Alg. N. Amer. 1873, p. 148, t. 21, f. 18, t. 13, f. 9; Kirchn. Alg. Schles. 1878, p. 168; Wille, Norges Ferskv. Alg. 1880, p. 40; Wolle, Desm. U. S. 1884, p. 121, t. 40, f. 7–11, 17–22 (ex parte); Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 247; Cooke, Brit. Desm. 1887, p. 138, t. 49, f. 1; De Toni, Syll. Alg. 1889, p. 1137; West, Alg. W. Ireland, 1892, p. 170; Alg. Engl. Lake Distr. 1892, p. 18; Schmidle, Beitr. Algenfl. Schwarzwald u. Rheineb. 1893, p. 107, t. 5, f. 26, 27 (forma); Roy & Biss. Scott. Desm. 1894, p. 19; Schmidle, Beitr. Alp. Alg. 1895, p. 30, t. 16, f. 30, 31; W. & G. S. West, Alga-fl. Yorks. 1901, p. 96; Comère, Desm. de France, 1901, p. 161, t. 13, f. 18; W. & G. S. West, Alg. N. Ireland, 1902, p. 44; Freshw. Alg. Ceylon, 1902, p. 175; Scott. Freshw. Plankton, I, 1903, p. 528; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24; Comp. Study Plankton Irish Lakes, 1906, p. 86; Gutw. Flor. Alg. Mont. Tatr. 1909, p. 470; Kaiser, Beitr. Alg. Traunstein Chiemgau, 1914, p. 152.
St. mucronatum Ralfs in Ann. Mag. Nat. Hist. 1845, p. 152, t. 10, f. 5 (ex parte).
St. cuspidatum v. *dejectum* Kütz. Spec. Alg. 1849, p. 179.
Didymidium (*Staurastrum*) *erectum* Reinsch, Alg. Frank, 1867, p. 157 (ex parte); Contr. Alg. Fung. 1875, p. 86, t. 15, f. 8.
Staurastrum laniatum Delp. Spec. Desm. Subalp. 1877, p. 39, t. 10, f. 25 (in part).
St. dejectum var. *α lunatum* Cooke, Brit. Desm. 1887, p. 138, t. 49, f. 1*a*.
St. dejectum f. *punctata* West, Add. Alg. W. Yorks. II, 1891, p. 247.

Cells small, about as long as broad (not including the spines), deeply constricted, sinus widely open, acute or obtusely rounded at the apex, often nearly rectangular; semicells usually more or less triangular in outline,

rarely elliptical, dorsal and lateral margins nearly straight or very slightly convex; with a long spine at each angle; spines usually somewhat diverging, sometimes parallel, and very rarely converging. Vertical view triangular, rarely quadrangular, lateral margins slightly concave, angles slightly turgid and terminated by a strong spine. Chloroplast axile with a central pyrenoid and two lobes projecting into each angle.

Zygospore spherical, with a number of rather short, stout spines, broad at their base.

Length, not including the spines, 18–27 μ; breadth, not including the spines, 17–27 μ; breadth of isthmus 5–8 μ; length of spines 3–8 μ; diam. zygosp., without spines, 32·5 μ; length of spines, 5–10 μ.

England.—Cumberland! Westmoreland! Lancashire (*Ralfs*). W., N., and E. Yorks! Essex! Warwicks (*Wills*). Surrey! Sussex! Kent (*Ralfs*). Hants! Wilts! Devon! (*Harris*). Cornwall! Plankton of Ennerdale Water, Cumberland, and of Hawes Water and Stickle Tarn, Westmoreland!

Wales.—Capel Curig (*Cooke & Wills*). Llyn Idwal, Llyn Ogwen, Llyn Geirionedd, Llyn Bodgynwydd and Y Foel Fras, Carnarvonshire! In the plankton.

Scotland.—General: zygospores not uncommon (*Roy & Biss.*). Bute! Loch Doon, Ayrshire! Wigtownshire! Lewis and Harris, Outer Hebrides! General in the plankton!

Ireland.—Donegal! Mayo and Clare Island! Galway! Kerry! Dublin and Wicklow (*Arch.*). Londonderry! In the plankton!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Hungary. Servia. Italy. Norway. Finmark. Sweden. Poland. N., Central and S. Russia. Faeroes. Iceland (var.). Greenland. Siberia. Mongolia. Central China. Japan. India. Ceylon. Australia. New Zealand (var.). E. Africa. Alaska. United States. Canada. Colombia.

St. dejectum is an extremely common and widely distributed

species and, at the same time, it is somewhat variable in form and in the inflexion of its spines. These are usually inserted near the apex of the semicell and are, as a rule, slightly divergent or parallel. The more or less triangular form of the semicells and the dorsal insertion of its spines are the features by which it can be distinguished from *St. mucronatum*. In the latter species the semicells are more elliptical in form and the spines are lateral in their insertion.

There has been much confusion in the past between *St. dejectum* and *St. mucronatum*, particularly with regard to the zygospores. Ralfs (in 'Brit. Desm.' 1848) united the two species and figured them under the name of *St. dejectum*. The conjugating specimens figured by him belong most probably to *St. mucronatum*, as is evident from the shape of the semicells (see 'Nordst. Freshw. Alg. N. Zeal.' 1888, p. 40). These zygospores have been copied by many authors and reproduced under the name of *St. dejectum*. The zygospore of *St. dejectum* is, however, not well known, since it has only been figured by De Bary (' Conj.' 1858, t. 6, f. 26–32) and Reinsch (' Contrib. Alg. Fung.' 1875, t. 15, f. 8).

Forma **major** West & G. S. West. (Pl. CXXIX, fig. 13.)

Staurastrum dejectum forma West & G. S. West, Comp. Study Plankton Irish Lakes, 1906, p. 102, t. 11, f. 16.

Differs from the type in its larger size and much stouter spines.

Length, without spines, 42 μ ; breadth, without spines, 48 μ ; breadth, including spines, 80–85 μ ; breadth of isthmus 11 μ.

IRELAND.—Plankton of Lough Corrib, Galway !

Var. **patens** Nordst. (Pl. CXXX, figs. 1, 2.)

Staurastrum dejectum β patens Nordst. in Botan. Notis. 1887, p. 158 ; Freshw. Alg. N. Zeal. 1888, p. 39, t. 4, f. 16 ; De Toni, Syll. Alg. 1889, p. 1138 ; West, Alg. Engl. Lake Distr. 1892, p. 18 ; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 27, t. 1, f. 11 ; Gutw. Flor. Alg. Mont. Tatr. 1909, p. 470 ; Borge, Sao Paulo Süsswasseralgen, 1918, p. 47.

A form with small spreading spines which are divergent ; sinus acute-angled, isthmus not even slightly elongated.

Length 21–26 μ; breadth 21–25 μ; breadth of isthmus 6–7 μ; length of spines up to 2·5 μ.

ENGLAND.—Brother's Water, Westmoreland! Enbridge Lake, Hants (*Roy*).

SCOTLAND.—Alford and Tomachar, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Finland. Italy. Austria. Australia. New Zealand. Brazil. Patagonia.

The more elliptical and inflated form of the semicells and the small spreading spines seem to be characteristic of this variety.

Var. **inflatum** West. (Pl. CXXX, figs. 3–5.)

Staurastrum dejectum var. *inflatum* West, Alg. W. Ireland, 1892, p. 170, t. 22, f. 11; West & G. S. West, Alg. N. Ireland, 1902, p. 44; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24; Borge, Botan. Notis. 1913, p. 27.

Cells much larger than in the type, semicells more elliptical in form and very inflated, sinus acute, spines at the angles much shorter and directed outwards.

Length, without spines, 35·5–43 μ; breadth, without spines, 33·5–52 μ; breadth of isthmus 10·3–12 μ; length of spines 2·8–4·3 μ.

WALES.—In the plankton!

SCOTLAND.—Loch Ruar, Sutherland! Plankton of Loch Mor Bharabhais and Loch Cuthaig, Lewis, Loch Laxadale, Harris, and Loch nan Eun, N. Uist, Outer Hebrides! Plankton of the Orkneys and Shetlands!

IRELAND.—Derryclare Lough, Ballynahinch, and in the plankton of Lough Corrib, Co. Galway! Plankton of Lough Neagh and Lough Beg, Londonderry!

Geogr. Distribution.—Sweden. Norway.

This large variety is more frequent in plankton than in any other habitat. Borge ('Botan. Notiser.' 1913, p. 27) suggests that it is simply a large form of var. *patens* Nordst., and certainly it does resemble this variety in the form of its semicells.

ST. DEJECTUM var. CONVERGENS Wolle, 'Desm. U. S.' 1884, p. 121, t. 40, f. 7, 9–11; De Toni, 'Syll. Alg.' 1889, p. 1138; Harris in 'Journ. Quek. Micr. Club,' 1920, p. 25. Harris (*loc.*

cit.) records this variety for Woodbury Common, E. Devon, which is the first British locality for it. Exactly what Wolle intended us to understand by his variety *convergens* is difficult to decide. His figures are very bad, and some of them bear a strong resemblance to *St. glabrum* (Ehr.) Ralfs, or to *Arthrodesmus convergens* Ehr. The writer is of the opinion that Wolle's description and figures are wholly inadequate as the basis of a valid variety, and believes that specimens recorded under this name have in all probability been either forms of *Staurastrum glabrum* or simply *St. dejectum* with slightly convergent spines.

46. **Staurastrum mucronatum** Ralfs.

(Pl. CXXX, figs. 10–12.)

Staurastrum mucronatum Ralfs in Ann. Mag. Nat. Hist. 1845, p. 152, t. 10, f. 5, 6 (ex parte); Bréb. Liste Desm. 1856, p. 142; Nordst. Desm. Spetsb. 1872, p. 38; Gay, Monogr. loc. Conj. 1884, p. 67; Roy & Biss. Scott. Desm. 1894, p. 22; West & G. S. West, Alga-fl. Yorks. 1902, p. 96; Alg. N. Ireland, 1902, p. 44, t. 2, f. 31; Borge, Botan. Notis. 1913, p. 28.

Goniocystis (Trigonocystis) mucronata Hass. Brit. Freshw. Alg. 1845, p. 350, t. 84, f. 8 (ex parte).

Staurastrum dejectum β Ralfs, Brit. Desm. 1848, p. 121, t. 20, f. 5 (ex parte).

Phycastrum (Amblyactinium) mucronatum Näg. Gatt. einz. Alg. 1849, p. 125.

Staurastrum dejectum forma Reinsch, Contrib. Alg. et Fung. 1875, p. 90, t. 13, f. 7.

St. dejectum var. *mucronatum* Kirchn. Alg. Schles. 1878, p. 169; Wolle, Desm. U. S. 1884, p. 121, t. 40, f. 8; Cooke, Brit. Desm. 1887, p. 139 t. 55, f. 7; De Toni, Syll. Alg. 1889, p. 1137; Gutw. Nonn. Alg. Nov. 1896, p. 27, t. 7, f. 69; Comère, Desm. de France, 1901, p. 161, t. 12, f. 28; Teodoresco, Matér. flor. alg. Rouman. 1907, p. 183.

Cells small, about as long as broad, deeply constricted, sinus open and acute-angled; semicells elliptic, dorsal margin more convex than in *St. dejectum*, ventral margin more convex than the dorsal; angular spines rather short, projecting horizontally, rarely converging. Vertical view usually triangular, lateral margins concave, angles very turgid, ending in a short stout spine. Chloroplast axile with a central pyrenoid, and a pair of lobes stretching into each angle.

Zygospore spherical, furnished with numerous conical spines.

Length 22–26 μ; breadth, without spines, 18–25 μ; length of spines 3–3·5 μ; breadth of isthmus 6·7–7 μ;

diam. zygosp., without spines, 33·7 μ; length of spines 12·5 μ.

England.—Wastdale, Cumberland! Helvellyn and near Bowness, Westmoreland (*Biss.*). Cullingworth and near Settle, W. Yorks! Mickle Fell and Pilmoor, N. Yorks! Risley Bog (*Roy*) and Hampsfell, Lancashire! Leicester (*Roy*). Enbridge Lake, Hants (*Roy*). Keston Common, Kent!

Wales.—Capel Curig, Carnarvonshire!

Scotland.—General, but scarce (*Roy & Biss*).

Ireland.—Lough Gartan, Donegal! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Roumania. Norway. Sweden. Bornholm. Poland. Spitzbergen. Siberia. N. India. United States. Alaska.

This species is not quite as common as *St. dejectum*, to which it is very closely allied. It is distinguished from the latter by its more convex apex and elliptical semicells, whilst its laterally inserted spines, which are rather small, are either parallel or more rarely slightly converging. In *St. dejectum* the semicells are cuneate rather then elliptic.

Var. **subtriangulare** West & G. S. West. (Pl. CXXX, figs. 13, 14.)

St. mucronatum var. *subtriangulare* W. & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 545, t. 17, f. 11; Freshw. Alg. Burma, 1907, p. 213, t. 15, f. 20; Borge, Botan. Notiser, 1913, p. 28.

Cells rather larger than in the type, the sinus more widely open; dorsal margin of semicell nearly straight or slightly convex, ventral margin nearly semicircular.

Length 26–44 μ; breadth, without spines, 29–44 μ; length of spines 3·8–4·6 μ; breadth of isthmus 6–13 μ.

England.—Plankton of Grasmere, Westmoreland!

Wales.—In the plankton!

Scotland.—Plankton of Loch Doon, Ayrshire!

Geogr. Distribution.—Sweden. Finland. Burma.

47. **Staurastrum O'Mearii** Arch.

(Pl. CXXXII, figs. 5–8.)

Staurastrum O'Mearii Arch. Suppl. Cat. Desm. 1858, p. 254, t. 21, f. 8–13; in Pritch. Infus. 1861, p. 738; Rabenh. Flor. Europ. Alg. 1868, p. 204; Nordst. Norges Desm. 1873, p. 27; Arch. in Journ. Bot. 1874, p. 93; Gay, Monogr. loc. Conj. 1884, p. 66; Cooke, Brit. Desm. 1887, p. 142, t. 50, f. 1; De Toni, Syll. Alg. 1889, p. 1143; Lütkem. Desm. Attersees, 1893, p. 563; Roy & Biss. Scott. Desm. 1894, p. 23; West & G. S. West, Alg. S. Engl. 1897, p. 493; Comère, Desm. de France, 1901, p. 163, t. 11, f. 22; West & G. S. West, Alg. N. Ireland, 1902, p. 44; Georgev. Desm. Wlasina-See, 1909, p. 203; Borge, Botan. Notis. 1913, p. 28.

St. Pseudincus Reinsch, Spec. Gen. Alg. 1867, p. 15, t. 5, c.II, f. 1–5 (ex parte = f. 2-gona).

Arthrodesmus Incus v. *intermedius* Wittr. Skandinav. Desm. 1869, p. 15, t. 1, f. 6 (f. 2-gona); Jacobs. Desm. Danem. 1875, p. 205, t. 8, f. 26, *b* & *c*.

Cells very small, about as long as broad, constriction not very deep, sinus rectangular, somewhat acute at its apex; semicells triangular, apex broad and truncate, lateral margins very slightly convex, upper angles subacute and each furnished with a fairly stout diverging spine. Vertical view 2–4- (usually 3-) angled, sides very slightly convex, angles with a stout spine.

Zygospore spherical, with numerous long and delicate spines.

Length, without spines, 12–17 μ; breadth, without spines, 10–18·5 μ; breadth of isthmus 5–8 μ; length of spines 5–10 μ; diam. zygosp., without spines, 12–14 μ.

England.—Borrowdale, Cumberland! Near Bowness (*Biss.*), Helvellyn, Scandale and Stickle Tarn, Westmoreland! Cocket Moss, near Giggleswick, and bog 2 miles south of Clapham, W. Yorks! Puttenham and Thursley Commons, Surrey! Enbridge Lake, Hants (*Roy*). Dartmoor, Devonshire (*Harris*). Halgavor Moor, Cornwall!

Wales.—Capel Curig, Snowdon, and Glyder Fach (at 2,200 ft.), Carnarvonshire! Ffestiniog, Merioneth!

Scotland.—Sutherland, Aberdeen, Kincardine, Forfar, Perth, Argyle and Arran (*Roy & Biss.*). Orkneys!

Ireland.—Donegal! Galway! Kerry! Dublin and Wicklow (*Arch.*). Down!

Geogr. Distribution.—France. Austria. Servia. Norway. Sweden. United States. Colombia.

In the sterile condition this species can scarcely be distinguished from the one following, namely, *St. pterosporum* Lund. When zygospores are present the two cannot be confused, since the zygospores of *St. O'Mearii* are spherical and spiny, whilst in *St. pterosporum* they are smooth and angular. The sterile cells of *St. O'Mearii* are somewhat larger than those of *St. pterosporum*, whilst the spines are also considerably longer and stouter. It is also very similar to some forms of *St. dejectum*, but is usually smaller and less deeply constricted.

Var. **minutum** West. (Pl. CXXXII, fig. 9.)

Staurastrum O'Mearii var. *minutum* West, Alg. W. Ireland, 1892, p. 172, t. 22, f. 15.

Cells minute, smaller than in the typical form, a little shorter than broad, excluding the spines, apex of semicells slightly concave, spines proportionately longer; angles in vertical view extremely acute.

Length, without spines, 7–8 μ; breadth, without spines, 10 μ; length of spines 10 μ; breadth of isthmus 5 μ.

SCOTLAND.—Lewis, Outer Hebrides!

IRELAND.—Cromagloun, Co. Kerry!

48. **Staurastrum pterosporum** Lund.

(Pl. CXXXII, figs. 1–4.)

Staurastrum pterosporum Lund. Desm. Suec. 1871, p. 60. t. 3, f. 29; Arch. in Ann. Mag. Nat. Hist. 1881, p. 233; Cooke, Brit. Desm. 1887, p. 143, t. 50, f. 2; ? Nordst. Freshw. Alg. N. Zealand, 1888, p. 40; De Toni, Syll. Alg. 1889, p.1143; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 65; Roy & Biss. Scott. Desm. 1894, p. 24; ? West & G. S. West, Some N. Amer. Desm. 1896, p. 256; Alg. N. Ireland, 1902, p. 44; Brit. Freshw. Phytoplankton, 1909, p. 203; Georgev. Desm. Wlasina-See, 1909, p. 203; G. S. West, Contrib. Freshw. Alg. Columbia, 1914, p. 1045.

Cells minute, about as long as broad, constriction not very deep, sinus widely open, acute at the apex; semicells somewhat cuneate, broadening towards the apex, which is broadly truncate; sides straight or very

slightly convex, upper angles subacute, and tipped with a very delicate spine. Vertical view triangular, very rarely biradiate, lateral margins in the triangular form straight or slightly concave, angles rounded, each with a minute spine.

Zygospore compressed, rectangular, angles produced and each lodged in one of the four semicells of the conjugating cells, whose form they simulate.

Length, without spines, = breadth without spines = 10–15 μ; breadth of isthmus 5·5–6·5 μ; length of spines 2–4 μ; length of zygospore 20 μ; breadth 13 μ.

England.—Near Bowness, Westmoreland (*Biss.*). Delamere, Cheshire (*Roy*). Dartmoor, Devonshire (*Harris*).

Wales.—Glyder Fawr, Carnarvonshire (*Roy*).

Scotland.—Not uncommon: zygospore from near Aboyne, Aberdeen (*Roy & Biss.*). Sutherland!

Ireland.—Lough Anna, Lough Machugh and near Glenties, Donegal! Adrigole, Co. Cork! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—Servia. Galicia in Austria. Sweden. Finland. Greenland. New Zealand. United States. Colombia.

This species is very similar to the preceding one, from which it can scarcely be distinguished in the sterile condition (see above). It is fairly widely distributed in the British Isles, but is probably frequently overlooked. It is very much more common in the western parts, however, than in other localities. The biradiate form is known from Austria.

49. **Staurastrum connatum** (Lund.) Roy & Biss.

(Pl. CXXX, figs. 6–8.)

Staurastrum dejectum var. *connatum* Lund. Desm. Suec. 1871, p. 60, t. 3, f. 28; Wille, Norges Ferskv. Alg. 1880, p. 41; Turn. Freshw. Alg. E. India, 1893, p. 106.

St. hexacanthum Gay, Monogr. loc. Conj. 1884, p. 67, t. 2, f. 9 (forma).

St. connatum Roy & Biss. Jap. Desm. 1886, p. 237; De Toni, Syll. Alg. 1889, p. 1138; Börg. Desm. Brasil. 1890, p. 44; West, Freshw. Alg. W. Ireland, 1892, p. 171; Roy & Biss. Scott. Desm. 1894, p. 18; West & G. S. West, Alga-fl. Yorks. 1902, p. 96; Alg. N. Ireland, 1902, p. 43; Freshw. Alg Ceylon, 1902, p. 175; Hustedt, Desm. et Bacill. aus Tirol, 1911, p. 339.

Cells small, about as long as broad, or up to $1\frac{1}{4}$ times longer than broad, excluding the spines, deeply constricted, sinus subrectangular, often acute at the apex, opening broadly; semicells obversely subsemicircular, ventral margin very strongly convex, dorsal margin nearly straight, or even slightly concave, upper angles of semicells somewhat acutely rounded, with a long erect spine projecting from each. Vertical view triangular, lateral margins slightly concave, angles broadly rounded, spines very small (as a result of foreshortening).

Zygospore of type unknown, but probably more or less rounded, with a few short stout conical spines (*cf.* zygote of var. *Spencerianum*, Pl. CXXX, fig. 9).

Length, without spines, 21–29·5 μ; breadth 20–22·5 μ; breadth of isthmus 6·6–9·2 μ; length of spines 8–13 μ.

England.—Strensall Common, N. Yorks (*W. B. Turn.*). Riccall Common, E. Yorks! Dartmoor, Devonshire! Gunwen Moor, Cornwall!

Wales.—Bettws-y-coed (*Roy*), and Capel Curig! Carnarvonshire.

Scotland.—General (*Roy & Biss.*). Rhiconich, Sutherland!

Ireland.—Lough Anna and near Lough Magrath, Donegal! Dublin and Wicklow (*Arch.*). Lough Derryadd, Armagh!

Geogr. Distribution.—Austria. Norway. Finmark. Sweden. Bornholm. Finland. Poland. Central China. Japan. Turkey in Asia. Ceylon. Australia. New Zealand. United States. Brazil.

St. connatum is widely distributed but is not quite as common as some of the other allied species. The form of its semicells and its long erect spines readily distinguish it from all other Desmids of the *Staurastrum dejectum* series.

50. **Staurastrum jaculiferum** West.

(Pl. CXXX, figs. 17, 18; Pl. CXXXI, figs. 1–3.)

Staurastrum jaculiferum West, Alg. W. Ireland, 1892, p. 172, t. 22, f. 14; Racib. Desm. Tapakoomas, 1895, p. 34; Börg. Freshw. Alg. Faeroes,

1901, p. 232, t. 8, f. 1; West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 543, t. 17, f. 1–4; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 485, t. 1–5; Comp. Study Plankton Irish Lakes, 1906, p. 103, t. 11, f. 17–19; Brit. Freshw. Phytoplankton, 1909, p. 168; Phytoplankton Engl. Lake Distr. 1909, p. 189; Period. Phytoplankton Brit. Lakes, 1912, p. 417.

Arthrodesmus longicornis Roy & Biss. Scott. Desm. 1894, p. 28 (forma *biradiata*).

Cells small, about $1\frac{1}{2}$ times longer than broad, deeply constricted, sinus acute-angled, widening considerably; semicells roughly triangular, lateral margins convex, and apex subconvex, the upper angles provided with very long, strong and diverging spines. Vertical view 2–4-radiate, lateral margins convex, with a strong spine at each angle. Chloroplast axile, with a central pyrenoid and a pair of lobes stretching into each angle.

Zygospore unknown.

Length, without spines, 20–31 μ; breadth, without spines, 14–22 μ; length of spines 15–38 μ; breadth of isthmus 5·5–8 μ; thickness (in forma biradiata) 12·5–14 μ.

England. — Plankton of Buttermere, Crummock Water, Ennerdale (f. 2-radiata) and Wast Water, Cumberland! Plankton of Brother's Water, Red Tarn (f. 2- and 3-radiatæ), Hawes Water, Codale Tarn, Easedale Tarn, and Windermere, Westmoreland!

Wales.—In the plankton (f. 2-radiata). Llyn Cwlyd, Carnarvonshire!

Scotland.—Fairly general in the plankton of the mainland (both 2- and 3-radiate forms), of the outer Hebrides, and of the Orkneys and Shetlands!

Ireland.—Lough Guitane, and common in the plankton, Co. Kerry! Rare in the plankton of Lough Keel, and Lough Gall (f. 2-radiata), Co. Mayo!

Geogr. Distribution.—Norway. Finmark. Finland. Faeroes. Greenland. Guiana.

St. jacutiferum is almost entirely confined to plankton, or is otherwise an inhabitant of large lakes. In some of the lakes in S.W. Ireland and W. Scotland it forms a very prominent feature of the plankton, and it is also fairly general in the plankton of the Welsh lakes, and of the English Lake District, but is apparently

wanting in the plankton of the Midlands. Thus it is a truly western type of Desmid, being confined to the drainage area of the older palæozoic rocks (see W. and G. S. W., 'Brit. Freshw. Plankton,' 1909, p. 202).

St. jaculiferum occurs in 2–4-radiate forms, the biradiate form occurring in some plankton collections to the exclusion of all other forms. The 3-radiate form is, however, the usual one, and the 4-radiate form is comparatively rare. It has been proved beyond all doubt that *Arthrodesmus longicornis* Roy & Biss. is simply the biradiate form of this species, since specimens are occasionally met in which one semicell is of the 2-radiate form and the other 3-radiate. The biradiate form is also often characterised by its slightly longer isthmus, and less divergent spines. The inflexion of the spines seems, however, to be subject to much variation in all forms of the species, the spines being sometimes nearly parallel, and in other cases very divergent.

The species is very well defined, and is nearest to *St. aristiferum* Ralfs, from which it is very readily distinguished by the more simple form of its semicells.

Var. **excavatum** W. & G. S. West. (Pl. CXXXI, figs. 4, 5.)

Staurastrum jaculiferum var. *excavatum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 544, t. 17, f. 5.

Differs from the type in its broadly obtuse sinus and elongated cylindrical isthmus.

Length, without spines, 26–27 μ; breadth, without spines, 16–19 μ; length of spines 21–29 μ; breadth of isthmus 8·5 μ.

SCOTLAND.—Plankton of Loch Shin and Loch Ghriama, Sutherland! Plankton of Loch near Cearnabahl and Loch Langabhat, Lewis, and Loch Diracleet, Harris, Outer Hebrides!

IRELAND.—Rare in plankton of Lough Caragh, Co. Kerry!

Var. **subexcavatum** W. & G. S. West. (Pl. CXXXI, fig. 6.)

Staurastrum jaculiferum var. *subexcavatum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 544, t. 17, f. 6–8.

A form with smaller cells and relatively stouter spines; sinus broadly rounded and isthmus cylindrical.

Length, without spines, 25–28 μ; breadth, without spines, 16–18 μ; length of spines 25–31 μ; breadth of isthmus 6·5–7 μ.

SCOTLAND.—Plankton of Loch Ruar, Loch Morar and Loch Ghriama, Sutherland!

51. **Staurastrum curvatum** West.

(Pl. CXXX, figs. 15, 16.)

Staurastrum curvatum West, Alg. W. Ireland, 1892, p. 172, t. 22, f. 13; West & G. S. West, Scott. Freshw. Plankton, I, p. 543, t. 17, f. 12; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 485; Brit. Freshw. Phytoplankton, etc., 1909, p. 202; Wahlburg, Bidr. känne. Littoistrask, 1913, p. 48.

Cells of medium size, rather longer than broad, not including the spines, deeply constricted, sinus nearly rectangular and obtuse at its apex, semicells lunate, directed away from each other; apex of semicell concave, each angle terminating in a long graceful diverging spine. Vertical view triangular, lateral margins concave, angles attenuated, and each one ending in a long spine. Cell-wall smooth; chloroplast axile, with a central pyrenoid and a pair of lobes extending into each angle.

Zygospore unknown.

Length, without spines, 25–32·5 μ; breadth, without spines, 20–35 μ; including spines, 71–75 μ; length of spines 20–23 μ; breadth of isthmus 5–8 μ.

ENGLAND.—Plankton of Buttermere, Ennerdale Water, Bassenthwaite Water, and Wast Water, Cumberland! Plankton of Codale Tarn, Grasmere, Stickle Tarn and Windermere, Westmoreland! Plankton of Bracebridge Pool, Sutton Park, Warwicks!

WALES.—In the plankton.

IRELAND.—Derryclare Lough and Ballynahinch, Co. Galway! Lough Guitane, Co. Kerry!

SCOTLAND.—Plankton of Loch Shin and Loch nan Cuinne, Sutherland! Loch Luichart and Loch Rosque, Ross! Plankton of Loch na Cloiche Sgoilt, Loch Morar,

and Loch Shiel, Inverness! Plankton of Loch Tay, Perthshire!; Loch Doon, Ayrshire!; Six lochs in Lewis, Outer Hebrides! Plankton of the Shetlands!

Geogr. Distribution.—Norway. Finland.

St. curvatum is most commonly found in the western parts of the British Isles, and is frequent in the plankton of nearly all the British lakes, especially those in the area of the older palæozoic rocks. It is almost entirely a plankton species, but has occasionally been reported from bogs.

52. **Staurastrum megacanthum** Lund.

(Pl. CXXXI, figs. 7, 8.)

Staurastrum megacanthum Lund. Desm. Suec. 1871, p. 61, t. 4, f. 1; Wills in Midl. Nat. 1881, p. 16, t. 5, f. 7; Wolle, Desm. U. S. 1884, p. 121, t. 51, f. 10–12; Cooke, Brit. Desm. 1887, p. 142, t. 49, f. 7; De Toni, Syll. Alg. 1889, p. 1141; Roy & Biss. Scott. Desm. 1893, p. 22; Schmidle, Lappm. Süsswasseralgen, 1898, p. 50, t. 2, f. 34 (forma); West & G. S. West, Alg. N. Ireland, 1902, p. 44; Alga-fl. Yorks, 1902, p. 96.

Cells of medium size, about as long as broad, not including the spines, or a little shorter, very deeply constricted, sinus acute-angled, sometimes almost rectangular; semicells triangular, or more often fusiform in outline, dorsal margin straight or slightly convex, ventral margin rather more inflated, angles gradually attenuated, each ending in a strong spine. Vertical view triangular or quadrangular, sides concave, each angle produced into a stout spine. Chloroplast axile, with a central pyrenoid and a pair of lobes projecting into each angle.

Zygospore unknown.

Length 43–50 μ; breadth, not including the spines, 48–57 μ; length of spines 11–18 μ; breadth of isthmus 12–14·5 μ.

England.—Wastdale, Cumberland! Plankton of Stickle Tarn, Westmoreland! Pilmoor, N. Yorks! Riccall Common, E. Yorks!

Wales.—Capel Curig, Carnarvonshire (*Cooke & Wills*)! Plankton of the Welsh Lakes!

Scotland.—Aberdeen, Kincardine, Perth and Argyle (*Roy & Biss.*). Loch Ghriama, Sutherland! Loch

Shiel, Inverness! Loch Brandy (at 2080 ft.), Clova, Forfar! Loch Shubhaill and in 5 other lochs in Lewis, Outer Hebrides!

IRELAND.—In lakes, Clifden to Roundstone, Ballynahinch, and rare in the plankton, Galway! Dublin and Wicklow (*Arch.*). Lough Fea, Londonderry!

Geogr. Distribution.—Switzerland. Norway. Sweden. Finland. Faeroes. Iceland. India. United States. N.W. Canada. Patagonia.

This species bears a superficial resemblance to *St. mucronatum*, but differs in its larger size and more angular semicells. It is more abundant in plankton than in other situations.

Var. **scoticum** W. & G. S. West. (Pl. CXXXI, figs. 9, 10.)

? *Staurastrum megacanthum* forma Borge in Algol. Notiser 1897, p. 213, t. 3, f. 7.

St. megacanthum var. *scoticum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 544, t. 16, f. 8; Further Contrib. Plankt. Scott. Lochs, 1905, p. 485.

Apical margin of semicell straight or slightly concave; sinus a little more widely open; spines relatively longer, and slightly diverging.

Length, without spines, 35–44 μ; breadth, without spines, 38–51 μ; including spines 79–111 μ; length of spines 19–34 μ; breadth of isthmus 10·5 μ.

SCOTLAND.—Plankton of Loch Shin, Loch nan Cuinne and Loch Ghriama, Sutherland! Mull (*Borge*). Loch Doon, Ayr! Loch Langabhat, Lewis, and Loch Laxadale, Harris, Outer Hebrides!

Geogr. Distribution.—Scandinavia. Canada.

This variety is readily distinguished from the typical form of *St. megacanthum* by its slightly concave apex and strong, slightly diverging spines. [In the opinion of the writer this Desmid bears a strong resemblance to *St. curvatum* West, and might well be placed as a form of this species rather than with *St. megacanthum*. In deference to Professor West, however, it has been retained in the position originally assigned to it.]

53. **Staurastrum aristiferum** Ralfs.

(Pl. CXXXII, figs. 10, 11.)

Staurastrum aristiferum Ralfs, Brit. Desm. 1848, p. 123, t. 21, f. 2; Arch. in Pritch. Infus. 1861, p. 737; Rabenh. Flor. Europ. Alg. 1868, p. 204; Wood, Freshw. Alg. N. Amer. 1873, p. 149; Kirchn. Alg. Schles. 1878, p. 169; Turn. Alg. Strensall Common, 1883, f. 6; Wolle, Desm. U. S. 1884, p. 122, t. 40, f. 15, 16; Cooke, Brit. Desm. 1887, p. 141, t. 49, f. 6; De Toni, Syll. Alg. 1889, p. 1141; Roy & Biss. Scott. Desm. 1894, p. 17; Comère, Desm. de France, 1901, p. 163, t. 13, f. 15; West & G. S. West, Alga-fl. Yorks, 1902, p. 96; Cushman, in Bull. Torr. Bot. Club, 1907, p. 614; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 203.

Cells small, a little longer than broad, not including the spines, very deeply constricted, sinus acute, opening widely, with a small incision at its apex; semicells triangular in outline, the central part somewhat tumid, angles rather inflated and produced obliquely upwards, ending in a long spine; apex of semicell truncate or slightly inflated in the middle; lateral margins with two slight undulations. Vertical view usually quadrangular, rarely triangular, lateral margins in the 4-angled specimen strongly concave, in 3-angled specimens convex in the middle, angles projecting and ending in a long spine.

Zygospore unknown.

Length, without spines, 26–30 μ; breadth, without spines, 24–27 μ; breadth of isthmus 6–7 μ; length of spines 14–19 μ.

ENGLAND.—Brother's Water, Westmoreland! Mickle Fell! and Strensall Common (*W. B. Turn.*), N. Yorks.

WALES.—Capel Curig! (*Cooke & Wills*) and Llyn-y-cwm-ffynon, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Inverness, Aberdeen, Kincardine, Perth and Dumbarton (*Roy & Biss.*). Rhiconich, Sutherland!

IRELAND.—Achill Island, Mayo! Derryclare Lough and Kylemore, Co. Galway!

Geogr. Distribution.—France. Germany. Austria. Norway. Sweden. India. Australia. United States. Brazil.

Var. **protuberans** W. & G. S. West. (Pl. CXXXII, fig. 12.)

Staurastrum aristiferum var. *protuberans* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 544, t. 14, f. 5.

Apex of semicell strongly convex in the middle portion; vertical view triangular with the lateral margins very convex in the middle.

Length, without spines, 23–27 μ; breadth, without spines, 24–27 μ; length of spines 13·5–17 μ; breadth of isthmus 9·7 μ.

SCOTLAND.—Plankton of Loch nan Eun, N. Uist, Outer Hebrides!

54. **Staurastrum cuspidatum** Bréb.

(Pl. CXXXII, figs. 13–15.)

Binatella tricuspidata Bréb. Alg. Falaise, 1835, p. 57, t. 8.
B. cuspidata Bréb. in Cheval. microsc. et usage, 1839, p. 272.
Staurastrum cuspidatum Bréb. in Menegh. Synops. Desm. 1840, p. 226; Ralfs, Brit. Desm. 1848, p. 122, t. 22, f. 1, and t. 33, f. 10; Arch. in Pritch. Infus. 1861, p. 737, t. 1, f. 31–34; Rabenh. Krypt. Fl. Sachs. 1863, p. 189; Wittr. Gotl. Öl. sötv. 1872, p. 54; Delp. Desm. Subalp. 1877, p. 136, t. 10, f. 26–33; Kirchn. Alg. Schles. 1878, p. 169; Wolle, Desm. U. S. 1884, p. 123, t. 40, f. 23–25; Cooke, Brit. Desm. 1887, p. 141, t. 49, f. 5; Hansg. Prodr. Algenfl. Böhm. 1888, p. 211; De Toni, Syll. Alg. 1889, p. 1140; Roy & Biss. Scott. Desm. 1894, p. 19; Schmidle, Lappm. Süsswasser-algen, 1898, p. 49; Comère, Desm. de France, 1901, p. 163, t. 13, f. 24; Schröder, Gallertbildung Alg. 1902, p. 168, t. 7, f. 15; West & G. S. West, Alga-fl. Yorks. 1902, p. 97; Alg. N. Ireland, 1902, p. 44; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24; Phytoplankton Engl. Lake Distr. 1909, p. 289; Hustedt, Desm. Bacill. aus Tirol, 1911, p. 339.
Phycastrum cuspidatum Kütz. Phyc. Germ. 1845, p. 138; Spec. Alg. 1849, p. 179.
Ph. spinulosum Näg. Gatt. einz. Alg. 1849, p. 126, t. 8A, f. 2.

Cells small, about as long as broad, or a little longer, not including the spines, very deeply and broadly constricted, with a long cylindrical sinus about as long as a single semicell, sinus broad and obtuse, widening outwards; semicells fusiform, ventral margin more convex than the dorsal, lateral angles terminating in a stout spine, either parallel or converging. Vertical view usually triangular, rarely quadrangular, sides concave, angles inflated, each with a spine.

Zygospore spherical, with a limited number of long stout spines, swollen at the base.

Length, without spines, 20–31 μ ; breadth, without spines, 18–28 μ ; breadth of isthmus 5–7 μ ; length of spines 5–12 μ ; diam. zygosp., without spines, 25 μ ; including spines 55 μ.

ENGLAND. — Cumberland ! Westmoreland (*Biss.*). Lancashire ! W., N., and E. Yorks ! Essex ! Oxfordshire ! Plankton of Bracebridge Pool, Sutton Park, Warwicks ! Berks (*Griffiths*). Surrey ! Kent ! Hants (*Ralfs*) ; zygospores from New Forest ! Devonshire (*Harris*) ! Cornwall !

WALES.—Capel Curig (*Cooke & Wills*) ! Bettws-y-coed and Glyder Fawr (*Roy*), Dolbadarn Castle and Llyn Ogwen, Carnarvonshire ! Ffestiniog, Merioneth !

SCOTLAND.—Ross, Inverness, Banff, Aberdeen, Kincardine, Forfar, Perth and Argyle (*Roy & Biss.*). Mull (*Borge*). Orkneys and Shetlands !

IRELAND.—Donegal ! Mayo ! Galway ! Kerry ! Plankton of Lough Neagh ! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Hungary. Roumania. Italy. Norway. Sweden. Denmark. Bornholm. Finland. Poland. N. and S. Russia. Faeroes. Greenland. Siberia. Japan. Ceylon. Burma. Australia. New Zealand. Abyssinia. Central Africa. Nova Scotia. United States. Canada. Brazil.

St. cuspidatum is an extremely common and very widely distributed species, and its elongated isthmus is one of its most characteristic features. The spines usually converge slightly towards those of the other semicell.

Var. **maximum** West. (Pl. CXXXII, figs. 18, 19.)

Staurastrum cuspidatum var. *maximum* West, Add. Alg. W. Yorks. II, 1891, p. 247 ; Alg. Engl. Lake Distr. 1892, p. 18 ; West & G. S. West, Alg. S. England, 1897, p. 492 ; Schmidle, Lappmark Süsswasseralgen, 1898, p. 49, t. 2, f. 33 ; West & G. S. West, Alga-fl. Yorks. 1902, p. 97 ; Scott. Freshw. Plankton, I, 1903, p. 545, t. 17, f. 13 ; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24 ; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 486, t. 1, 5 ; Period. Phytoplankton Brit. Lakes, 1912, p. 414.

St. cuspidatum Borge in Botan. Notiser, 1897, p. 213.
St. cuspidatum var. *longispinum* Lemm. Beitr. Kenntnis Planktonalg. 1898, p. 153.
St. Daaei Huitfeldt-Kaas, Plankton Norske Vande, 1906, pp. 55 and 155, t. 2, f. 30, 31.

Cells much larger and isthmus broader than in the type, spines very long and stout, parallel or diverging, sometimes curved. Vertical view triangular, sides only slightly concave or nearly straight.

Length, without spines, 27–43 μ ; breadth, without spines, 24–30 μ ; breadth of isthmus 4–6·5 μ ; length of spines 10–18 μ.

England. — Plankton of Buttermere, Crummock Water, Bassenthwaite Water, and Wast Water, Cumberland ! Plankton of Brother's Water, Ullswater, Grasmere and Windermere, Westmoreland ! Malham Tarn, W. Yorks ! Epping Forest, Essex !

Wales.—In the plankton.

Scotland. — Rhiconich, Sutherland ! Common in the plankton of Ross, Inverness, Perth, Lewis and Harris, Outer Hebrides, and the Shetlands !

Ireland.—Plankton of Mayo and Kerry ! Plankton of Lough Neagh !

Geogr. Distribution.—Germany. Scandinavia. Finmark. Paraguay.

This large variety with its strong spines is a very common plankton form. The spines are variable in their inflexion, being usually curved slightly outwards, or sometimes parallel. The forms described by Borge from the plankton of Mull (in 'Botan. Notiser,' 1897, p. 213) probably belong to this variety.

Var. **divergens** Nordst. (Pl. CXXXII, figs. 16, 17.)

Staurastrum cuspidatum var. *divergens* Nordst. Desm. Brasil, 1870, p. 225, t. 4, f. 49; Gutw. Flor. Glonow Okolic Lwowa, 1891, p. 65; West, Freshw. Alg. W. Ireland, 1892, p. 171 ; Roy & Biss. Scott. Desm. 1894, p. 19 ; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 157, t. 4, f. 52 ; Alg. S. England, 1897, p. 492 ; Alga-fl. Yorks, 1902, p. 97.

Cells rather smaller than in the type, spines conspicuously divergent ; isthmus variable, elongated or sometimes very short.

Zygospore globose, with a number of prominent mamillæ, each mamilla provided with a single short spine.

Length, without spines, 23–25 μ; breadth, without spines, 21–23·3 μ; breadth of isthmus 6·6 μ; length of spines 5–10 μ; diam. zygosp., without mamillæ and spines, 23·5–25 μ; with mamillæ and spines 37–41 μ.

ENGLAND.—Whernside, W. Yorks! Keston Common, Kent (with zygospores)!

SCOTLAND.—Not uncommon (*Roy & Biss.*). Plankton of Loch Bairness, Inverness!

IRELAND.—Ballynahinch and Glendalough, Co. Galway! Adrigole, Co. Cork!

Geogr. Distribution.—Germany. Scandinavia. Paraguay.

Var. **coronulatum** Gutw. (Pl. CXXXIII, fig. 1.)

St. cuspidatum var. *coronulatum* Gutw. Wahr. d. Priorität, 1890, p. 71; Flor. Glon. Okolic Lwowa, 1891, p. 66, t. 3, f. 11; Roy & Biss. Scot. Desm. 1894, p. 19.

Angles of the semicell provided with a circle of tiny verrucæ just beneath the point of insertion of the spines.

Length 26 μ; breadth, with spines, 36 μ; breadth of isthmus 5–6 μ.

SCOTLAND.—Birsemore Loch, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Galicia in Austria. Norway.

It is perhaps worth noting that Schröder ('Gallertb. Alg.' 1902, p. 168, t. 7, f. 15) figures a circle of secreting pores in exactly the same position as the granules of Gutwinski's var. *coronulatum*. Possibly the supposed granules round the angles in this variety are merely the hardened heads of the gelatinous pore-threads, which, in so many Desmids, have frequently been mistaken for granules.

55. **Staurastrum pseudocuspidatum** Roy & Biss. (Pl. CXXXIII, figs. 2, 3.)

Staurastrum pseudocuspidatum Roy & Biss. Jap. Desm. 1886, p. 237, t. 268, f. 3; De Toni, Syll. Alg. 1889, p. 1146; West, Alg. N. Wales, 1890, p. 16; West & G. S. West, Alg. Madag. 1895, p. 73, t. 8, f. 44.

Cells small, about $1\frac{1}{3}$ times longer than broad, deeply constricted, sinus obtuse, nearly semicircular ; semicells relatively more broadly oval than in *St. cuspidatum*, each angle terminated by a short spine. End view triangular, sides concave, angles slightly inflated, and terminated by a short spine. Cell-wall minutely punctate.

Zygospore unknown.

Length, without spines, 20–35 μ ; breadth, without spines, 14–27 μ ; breadth of isthmus, 4–7 μ ; length of spines, 4–6 μ.

WALES.—Capel Curig, Carnarvonshire !

Geogr. Distribution.—Japan. Madagascar.

This species is distinguished from the preceding one by its relatively stouter and more broadly oval semicells. The spines are usually parallel, or sometimes very slightly incurved or divergent.

56. **Staurastrum leptodermum** Lund.

(Pl. CXXXII, fig. 20.)

Staurastrum leptodermum Lund. Desm. Suec. 1871, p. 58, t. 3, f. 26 ; De Toni, Syll. Alg. 1889, p. 1144 ; Roy & Biss. Scott. Desm. 1894, p. 22 ; West & G. S. West, Welw. Afric. Freshw. Alg. 1897. p. 45 (forma) ; Lütkem. Desm. Central China, 1900, p. 123, t. 6, f. 30, 31 (forma).

Cells of medium size, about as long as broad, deeply constricted, sinus broad and subrectangular ; semicells cuneate, widening considerably towards the apex, sides nearly straight, but with two obscure undulations, apex slightly tumid in the middle, angles terminating in a minute spine directed obliquely upwards. Vertical view triangular, sides straight, angles acute with a short spine. Cell-wall very thin ; chloroplast axile.

Zygospore unknown.

Length 58–60 μ ; breadth, without spines, = length ; breadth, with spines, 61–64 μ ; breadth of isthmus 22 μ.

SCOTLAND.—Slewdrum, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Sweden. Finland. Central China. Bengal.

57. **Staurastrum Ungeri** Reinsch.

(Pl. CXXXIII, fig. 5.)

Staurastrum Ungeri Reinsch, Spec. Gen. Alg. 1867, p. 24, t. 24 B, I, f. 1–6; De Toni, Syll. Alg. 1889, p. 1152; Roy & Biss. Scott. Desm. 1894, p. 26.
Didymidium (Staurastrum) Ungeri Reinsch, Algenfl. Frank. 1867, p. 174, t. 11, f. 3.
Staurastrum acanthophorum West & G. S. West, Alg. Madag. 1895, p. 72, t. 8, f. 10 (var.).

Cells small, about as long as broad, deeply constricted, isthmus one-third or more the diameter of the cell, sinus acute-angled; semicells elliptical, dorsal and ventral margins almost equally convex, lateral angles ending in a stout spine, in length one-third or one-fourth the diameter of the cell. Vertical view triangular or quadrangular, lateral margins straight or slightly concave, angles obtusely rounded, each with a stout spine. Cell-wall provided with numerous short conical spines, irregularly scattered, and about one-third or one-fourth the length of the larger angular spines.

Zygospore unknown.

Length = breadth = 27 or 28 μ; length of angular spines 8 μ.

SCOTLAND.—Loch Ruthven, Inverness; old channel of Dee, below Aboyne, Aberdeen; Keiloch, Kincardine (*Roy & Biss.*).

Geogr. Distribution.—Germany. Switzerland (var.). Madagascar (var.).

58. **Staurastrum tunguscanum** Boldt.

(Pl. CXXXIII, fig. 4.)

Staurastrum tunguscanum Boldt, Sibir. Chlorophy. 1885, p. 114, t. 5, f. 22; De Toni, Syll. Alg. 1889, p. 1146; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 66, t. 3, f. 12 (forma); Borge, Süssw. Chlor. Archang. 1894, p. 37; West & G. S. West, Alg. S. England, 1897, p. 493.

Cells small, slightly longer than broad, deeply constricted; sinus acute-angled, opening widely; semicells subtriangular, directed away from each other, lateral

margins convex, apex of semicells truncate or slightly retuse, angles produced to form a colourless recurved spine; cell-wall finely granulate-denticulate. Vertical view triangular, angles slightly inflated and ending in a short straight spine; lateral margins gently concave.

Zygospore unknown.

Length 19–30 μ; breadth, not including spines, about 19–24 μ; length of spines 6 μ; breadth of isthmus 7–10 μ.

ENGLAND.—Puttenham Common, Surrey!

Geogr. Distribution.—Germany. Galicia in Austria. Sweden. N. Russia.

St. tunguscanum is closely allied to *St. granulosum* (Ehr.) Ralfs and *St. lunatum* Ralfs. It differs from both these species in its distinctly truncate or retuse apex, and its angular spines are also very much stouter than the delicate spines of *St. granulosum*.

59. **Staurastrum lunatum** Ralfs.

(Pl. CXXXIII, figs. 17–19.)

Staurastrum lunatum Ralfs, Brit. Desm. 1848, p. 124, t. 34, f. 12; Arch. in Pritch. Inf. 1861, p. 738; Rabenh. Krypt. Fl. Sachs. 1863, p. 193; Flor. Europ. Alg. 1868, p. 221; Cooke, Brit. Desm. 1887, p. 143, t. 50, f. 5; De Toni, Syll. Alg. 1889, p. 1146; Racib. Desm. Nowe, 1889, p. 28; West, Add. Alg. W. Yorks. II, 1891, p. 247; Alg. W. Ireland, 1892, p. 173; Roy & Biss. Scott. Desm. 1894, p. 22; West & G. S. West, Alg. S. England, 1897, p. 493; Schröder, Gallertbildung Alg. 1902, p. 168, t. 7, f. 16; Teodoresco, Matér. flor. alg. Rouman. 1907, p. 184.

Cells rather under medium size, about as long as broad or a little shorter, not counting the spines, deeply constricted, sinus acute and widening outwards; semicells semicircular or almost lunate, directed away from each other, dorsal margin very slightly convex, ventral margin very tumid, upper angles of semicell obtuse, and ending in a short stout spine which projects obliquely outwards. Cell-wall uniformly rough with tiny granules arranged in concentric rows round the angles. Vertical view triangular, sides concave, angles terminating in a short spine, granules becoming smaller towards the

centre, apex of semicell almost smooth. Chloroplast axile with a central pyrenoid in each semicell.

Zygospore unknown.

Length, without spines, 35–39 μ; breadth, without spines, 35–43 μ; breadth of isthmus 10–13 μ; length of spines 3·5–12 μ.

ENGLAND.—Cumberland! Westmoreland! W., N., and E. Yorks! Essex! Oxford! Hants! Warwicks! Dartmoor, Devon (*Harris*). Cornwall (*Ralfs*).

SCOTLAND.—Near Tain, Ross; near Brin, Inverness; near Alford, S. of Birsemore, Dalbagie, Aberdeen (*Roy & Biss.*). Craig an Lochan, Perth! Mull in Argyle (*O. Borge*).

IRELAND.—Foxford, Co. Mayo! Derryclare Lough and Oorid Lough, Co. Galway! Near L. Brin, Co. Kerry.

Geogr. Distribution.—France. Germany. Roumania. Norway. Finland. Sweden. Faeroes. Greenland. Siberia. Azores. United States and Alaska.

The granules in the vicinity of the angles often tend to become developed into small spicules in this species, so that the angular spines may seem to be duplicated.

Var. **planctonicum** W. & G. S. West. (Pl. CXXXIII, figs. 20–22.)

Staurastrum lunatum var. *planctonicum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 546, t. 16, f. 11, 12; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24; Comp. Study Plankton Irish Lakes, 1906, p. 103; Brit. Freshw. Phytoplankton, 1909, p. 174.

Cells relatively broader and attaining a larger size than in the type, angles of semicells more acute and ending in a shorter spine. Vertical view triangular, angles gradually tapering to a short spine, lateral margins broadly retuse.

Length 40–44 μ; breadth, without spines, 42–50 μ; breadth of isthmus 14·5–16 μ; length of spines 3–5·5 μ.

ENGLAND.—Plankton of Crummock Water, Ennerdale Water, Bassenthwaite Water and Wast Water, Cumber-

land! Hayes Water, Red Tarn, Grasmere and Windermere, Westmoreland!

Wales.—In the plankton!

Scotland.—N. of Stornoway, Lewis! General in the plankton of many lochs in the mainland and Outer Hebrides! Plankton of Shetlands!

Ireland.—Plankton of Galway and Kerry!

Geogr. Distribution.—Norway. Finmark. Finland. Russian Lapland. N.W. Canada.

This variety is very frequent in plankton, and sometimes occurs in abundance. It is distinguished from typical *St. lunatum* by its more angular semicells, in which the angles are more produced, and end in much smaller spines. There is no very obvious constriction at the base of the spines. The entire cell is finely granulated, the granules being very acute and arranged in concentric series round the angles. It is similar to *St. lunatum* f. *alpestris* Schmidle (in 'Œst. Bot. Zeitschr.' 1895, p. 24, t. 16, f. 27), but differs in the more attenuated angles of the semicells which run directly into the spines, whilst its granulation is also more uniform.

60. **Staurastrum cornutum** Arch.

(Pl. CXXXIII, fig. 16.)

Staurastrum cornutum Arch. in Ann. Mag. Nat. Hist. 1881, p. 232; Cooke, Brit. Desm. 1887, p. 190; De Toni, Syll. Alg. 1889, p. 1175; Roy & Biss. Scott. Desm. 1893, p. 180, t. 3, f. 5; Grönblad, Desm. Keuru, 1920, p. 60, t. 2, f. 27, 28, t. 3, f. 54, 55.

Small; length and breadth equal; semicells oval, diverging widely from the isthmus, which is broad; sides with one simple or deeply cleft stout spine; end with about six small emarginate spines, and two rows of similar spines within the margin; end view triangular, with a stout spine at each angle, and about four small emarginate spines on the margin of the straight sides, and one row of similar spines within the margin (*Roy*).

Zygospore unknown.

Length and breadth, without side spines, 27 μ; isthmus 11 μ; length of spine 9 μ.

SCOTLAND.—Logie, Coldstone and Blairglas, Aberdeen; Glen Coe, Argyle (*Roy & Biss.*).

IRELAND.—Connemara (*Arch.*).

Geogr. Distribution.—Finland.

Until quite recently this species had never been seen since it was discovered by Archer except by Roy and Bissett. The latter investigators remark that it is "extremely rare," and that "its nearest ally is *St. maamense* Arch.," but that "the stout spines sufficiently distinguish it." Grönblad now records it from Finland.

61. **Staurastrum Gatniense** W. & G. S. West.

(Pl. CXXXV, figs. 14, 15.)

St. Gatniense West & G. S. West, Alg. N. Ireland, 1902, p. 48, t. 2, f. 35.

Cells small, slightly broader than long, not counting the spines, very deeply constricted, sinus open, narrow, and finally dilated at the extremity; semicells elliptic-trapeziform, apex broad and slightly undulate, basal angles provided with a short stout converging spine, lateral margins slightly convex, and with two distant spines. Vertical view triangular, angles tumid and with a ring of denticulations, sides smooth and very slightly concave.

Zygospore unknown.

Length 27·5 μ; breadth, without spines, 29 μ; with spines, 33·5 μ; breadth of isthmus 8 μ.

IRELAND.—Lough Gatny, Co. Donegal!

This peculiar *Staurastrum* is not very closely allied to any other British species of the genus.

62. **Staurastrum bifidum** (Ehr.) Bréb.

(Pl. CXXXIV, fig. 4.)

Desmidium bidens Ehr. Inf. 1838, p. 141, t. 10, f. 11.
Phycastrum bifidum Kütz. Phyc. Germ. 1845, p. 138: Spec. Alg. 1849, p. 180.
Staurastrum bifidum (Ehr.) Bréb. in Ralfs, Brit. Desm. 1848, p. 215; Arch. in Pritch. Inf. 1861, p. 741; Rabenh. Krypt. Fl. Sachs. 1863, p. 192;

Flor. Europ. Alg. 1868, p. 205; Lund. Desm. Suec. 1871, p. 62, t. 4, f. 2; Kirchn. Alg. Schles. 1878, p. 169; Cooke, Brit. Desm. 1887, p. 163, t. 57, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 212; De Toni, Syll. Alg. 1889, p. 1198; Roy & Biss. Scott. Desm. 1893, p. 17; Lütkem. Desm. Central China, 1900, p. 123; West & G. S. West, Freshw. Chlorophy. Koh Chang. 1901, p. 92; Freshw. Alg. Ceylon, 1902, p. 176; Freshw. Alg. Burma, 1907, p. 212, t. 16, f. 7.

Phycastrum (*Stenactinium*) *bifidum* Näg. Gatt. einz. Alg. 1849, p. 128.

Cells rather under medium size, about as long as broad, not counting the spines; constriction fairly deep, sinus subrectangular; semicells subelliptical or subtriangular, dorsal margin slightly convex, ventral margin very tumid, provided at each angle with two stout spines, which usually lie in the same horizontal plane and project obliquely downwards; cell-wall smooth. Vertical view triangular, sides straight or slightly concave, angles broad and bifid, lobes separated by a broad concavity, and each one tipped with a sharp spine.

Zygospore unknown.

Length 28–33 μ; breadth, without spines, 29–33 μ; with spines, 48–56 μ; breadth of isthmus 11·5–14 μ.

England.—Cornwall (*Marquand*).

Scotland.—Poolewe, Ross (*Roy & Biss.*).

Geogr. Distribution.—France. Germany. Hungary. Italy. Sweden. Finland. Poland. N. Russia. Central China. Japan. India. Ceylon. Burma. Siam. Java.

63. **Staurastrum longispinum** (Bail.) Arch.

(Pl. CXXXIV, fig. 1.)

Didymocladon ? longispinum Bail. Microscop. Observ. 1851, p. 36, t. 1, f. 17.

Staurastrum longispinum Arch. in Pritch. Inf. 1861, p. 743; Rabenh. Flor. Europ. Alg. 1868, p. 221; Wood, Freshw. Alg. N. Amer. 1874, p. 148; Wolle, Desm. U.S. p. 145, t. 41, f. 7; Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 249, t. 27, f. 28; De Toni, Syll. Alg. 1889, p. 1199; West, Alg. W. Ireland, 1892, p. 180; West & G. S. West, Alg. N. Ireland, 1902, p. 45; Scott. Freshw. Plankton, I, 1903, p. 545; Brit. Freshw. Phytoplankton, 1909, p. 174.

St. (*Schizastrum*) *longispinum* Turn. Freshw. Alg. E. India, 1893, p. 132, t. 23, f. 12.

Cells very large, deeply constricted, sinus acute, opening widely; semicells subelliptical or subtriangular, dorsal margin slightly convex, ventral margin more

strongly so, angles very slightly produced (almost imperceptibly) and provided with two stout spines of varying length, projecting obliquely outwards and lying in the same vertical plane, the two spines either parallel or converging. Vertical view triangular, sides slightly concave and angles broadly rounded. Cell-wall very thick and distinctly punctate. Chloroplasts numerous, in the form of parietal bands running longitudinally, with numerous scattered pyrenoids.

Zygospore unknown.

Length 90–120 μ; breadth, without spines, 73–100 μ; breadth of isthmus 36–41 μ; length of spines 9·5–32·5 μ.

ENGLAND.—Plankton of Ennerdale Water, Cumberland, and Grasmere, Westmoreland!

WALES.—Capel Curig! (*Cooke & Wills*) and Llyn-y-cwm-ffynon, Carnarvonshire!

SCOTLAND.—Plankton of Loch Shin, and Rhiconich, Sutherland! Plankton of Loch Shiel, Inverness! Plankton of Lochs Fadaghoda and Stranabhat, Lewis, and Loch nan Eun, N. Uist, Outer Hebrides!

IRELAND.—Near Lough Magrath, Donegal! Lough Aunierin, Co. Galway! Plankton of Lough Currane, Kerry! Adrigole, Co. Cork!

Geogr. Distribution.—Norway. Sweden. India. Australia. United States.

St. longispinum is a large and characteristic species which could not easily be confused with any other. It is very abundant in plankton. The spines are variable in length, and all stages occur between the typical long-spined form and the form known as var. *bidentatum*, in which they are very reduced.

Var. **bidentatum** (Wittr.) West. (Pl. CXXXIV, figs. 2, 3.)

St. bidentatum Wittr. Skand Desm. 1869, p. 16, f. 7.
St. (*Pleurenterium*) *longispinum* Lund. Desm. Suec. 1871, p. 73, t. 5, f. 1.
St. longispinum Cooke, Brit. Desm. 1887, p. 164, t. 56, f. 1.
St. longispinum, var. *bidentatum* West & G. S. West, Scott. Freshw. Plankt. I. 1903, p. 546; Cushman in Rhodora, 1905, vol. 7, p. 263, t. 64, f. 13.

Similar to the type in every way except that the spines

are very much reduced and the apex of the semicell is often not so convex.

Length 80–90 μ ; breadth, without spines, 75–85 μ ; length of spines 7–10 μ ; breadth of isthmus 30–35 μ.

ENGLAND.—Plankton of Ennerdale Water, Cumberland !

WALES.—In the plankton !

SCOTLAND.—Glen Coe, Argyle, 1878 (*Roy & Biss.*). Rhiconich, Sutherland ! Plankton of Lochs Fadaghoda and an Sgath, Lewis, Loch Diracleet, Harris, and Loch nan Eun, N. Uist, Outer Hebrides !

Geogr. Distribution.—Switzerland. Sweden. United States.

64. **Staurastrum Brasiliense** Nordst. (Pl. CXXXV, fig. 11.)

Staurastrum Brasiliense Nordst. Desm. Brasil. 1869, p. 227, t. 4, f. 39 ; Wolle, Freshw. Alg. U.S. 1887, p. 46, t. 60, f. 39, 40 ; De Toni, Syll. Alg. 1889, p. 1200 ; Cushman in Rhodora, vol. 7, 1905, p. 262.

Cells large, about $1\frac{1}{3}$ times longer than broad, deeply constricted with a broad sinus ; semicells shortly cuneate, broadening towards the apex which is truncate or slightly retuse, lateral margins concave ; upper angles each terminating in 3 stout diverging spines ; cell-wall punctate ; isthmus about one-half the diameter of the cell. Vertical view 4- (–5-) angled, angles terminating in 3 diverging spines (on one occasion 4 have been observed) ; lateral margins concave.

Zygospore unknown.

Length, not including the spines, 43–51 μ ; with spines, 56–77 μ ; breadth, not including the spines, 25–37 μ ; with spines 65–99 μ.

Geogr. Distribution.—Norway. Abyssinia. United States. Brazil.

Var. **Lundellii** W. & G. S. West. (Pl. CXXXV, figs. 12, 13.)

St. Brasiliense forma Lund. Desm. Suec. 1871, p. 73, t. 5, f. 2 ; Cooke, Brit. Desm. 1887, p. 165, t. 56, f. 2 ; Wolle, Desm. U. S. 1884, p. 146, t. 48, f. 1–3.

St. Brasiliense var. *Lundellii* West & G. S. West, Some N. Amer. Desm. 1896, p. 259; Notes Alg. II, 1900, p. 295; Scott. Freshw. Plankt. I, 1903, p. 546; Further Contrib. Freshw. Plankt. Scott. Lochs, 1905, p. 486.

St. Brasiliense var. *Lundellianum* Schmidle, Lappmark Süsswasseralgen, 1898, p. 58.

Cells very large, about $1\frac{1}{5}$ times longer than broad, deeply constricted; sinus broad, deeply excavated at its apex; semicells cuneate, sides and apex nearly straight, upper angles somewhat obliquely truncate, and provided with 3 stout spines each, 2 of which lie in the same horizontal plane, the third being inserted in a more dorsal position and at an angle to the others. Vertical view 5-, rarely 6-angled, sides deeply concave, angles broad and bifid, each lobe attenuated into a stout spine, and with a third spine at each angle lying between the other two, inserted on the apex. Chloroplast axile, with numerous pyrenoids.

Length, without spines, 75–80 μ; with spines 120–130 μ; breadth, without spines, 63–80 μ; with spines, 120–140 μ; breadth of isthmus 28–34 μ; length of spines 25–30 μ.

ENGLAND.—Plankton of Ennerdale Water, Cumberland, and Easedale Tarn, Westmoreland!

WALES.—Capel Curig, Carnarvonshire! (*Cooke & Wills*). In the plankton!

SCOTLAND.—Plankton of Loch Shin, Sutherland! L. Shiel, Inverness! Plankton of Loch Fadaghoda and L. an Sgath, Lewis, and L. nan Eun, N. Uist, Outer Hebrides.

IRELAND.—Foxford, Co. Mayo! Arderry Lough, and in the plankton, Galway! Cloonee Lough and in the plankton, Kerry!

Geogr. Distribution.—Norway. Sweden. Finland. United States. Paraguay.

This beautiful Desmid is a distinctly "western"* type, and is more frequent in plankton than in other situations, often occurring in abundance. With its three stout angular spines it is quite distinct from any other species. The cell-wall is

* *Vide* p. 18 *supra*.

usually of some thickness, and is distinctly punctate. The spines are hollow only at the extreme base.

65. **Staurastrum quadrangulare** Bréb.

(Pl. CXXXIV, fig. 5.)

Staurastrum quadrangulare Bréb. in Ralfs, Brit. Desm. 1848, p. 128, t. 22, f. 7, t. 34, f. 11; Arch. in Pritch. Infus. 1861, p. 741, t. 3, f. 24, 25; Rabenh. Flor. Europ. Alg. 1868, p. 215; Kirchn. Alg. Schles. 1878, p. 170; Wolle, Desm. U. S. 1884, p. 145, t. 41, f. 1–4; Cooke, Brit. Desm. 1887, p. 164, t. 55, f. 4; De Toni, Syll. Alg. 1889, p. 1199; West, Alg. Eng. Lake Distr. 1892, p. 20; Roy & Biss. Scott. Desm. 1893, p. 24; Eichler, Mat. Flor. Miedz. 1893, p. 62; and 1894, p. 131, t. 4, f. 46; West & G. S. West, Some N. Amer. Desm. 1896, p. 257, t. 16, f. 16, 17; Gutw. Wykaz. Glonow Wadow.-Makow. 1897, p. 161; Comère, Desm. de France, 1901, p. 166, t. 12, f. 23; Georgev. Desm. Macedonia, 1910, p. 244.

Didymidium Hystrix, A. minus, β tetragonum Reinsch, Algenfl. Frank. 1867, p. 171.

Staurastrum quadrangulare f. *major* Cooke, Brit. Desm. 1887, p. 164; Teodoresco, Mater. Flor. alg. Roumania, 1907, p. 186.

Cells small, in general outline subrectangular, sinus fairly deep and acute, almost linear; semicells rectangular, dorsal margin straight, lateral margins straight or slightly concave, ventral margin very slightly convex; angles of semicells provided typically with 4 spines each, one pair towards the apex and another at the base; spines conical and diverging, at times one or other of them duplicated or wanting. Vertical view typically 4-angled, rarely 3- or 5-angled, sides straight or very slightly concave, angles broad and very slightly produced, each bearing two superimposed pairs of spines.

Zygospore unknown.

Length 20–30 μ; breadth, including spines, 20–30 μ; breadth of isthmus 8–10 μ.

England.—Ambleside (*Ralfs*) and Loughrigg, Westmoreland!

Scotland.—Birsemore Loch, near Dinnet, and Dalbagie, Aberdeen (*Roy & Biss.*). Rhiconich, Sutherland! Tarbert, Harris!

Ireland.—Near Foxford, Co. Mayo! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Galicia in

Austria. Turkey-in-Europe. Norway. Sweden. Bornholm. Finland. Poland. N. Russia. Japan. Abyssinia (var.). Central Africa (var.). West Indies (var.). Brazil. Argentine (var.).

66. **Staurastrum quadrispinatum** Turn.

(Pl. CXXXV, figs. 5–7.)

St. quadrispinatum Turn. Notes Freshw. Alg. 1886, p. 35, t. 1, f. 4: Cooke, Brit. Desm. 1887, p. 164, t. 55, f. 5; De Toni, Syll. Alg. 1889, p. 1199; Johnson, Rare Desm. U. S. I, 1894, p. 289; West & G. S. West, Some N. Amer. Desm. 1896, p. 258, t. 18, f. 17; Borge, Nordamerik. Süsswasseralg. 1909, p. 11.

Cells small, $1\frac{1}{3}$ to $1\frac{1}{2}$ times longer than broad, not including the spines, deeply constricted, sinus open and acute; semicells elliptic-oblong, broader at the base than at the apex, often somewhat angular; apex nearly flat, ventral margin strongly convex, lateral margins truncate, angles of the semicell provided with 4 stout and strongly divergent spines, one pair at the upper and lower extremities of the angle respectively. Vertical view triangular, sides straight, angles broadly truncate, spines so divergent as to be almost perpendicular to the lateral margins, and nearly in a line with the truncate angles. Cell-wall finely punctate.

Zygospore unknown.

Length, without spines, 33–39 μ; breadth, without spines, 26–30·5 μ; breadth of isthmus 8–10·5 μ; length of spines 10 μ.

Wales.—Trelleck Common, Monmouth (*Turn.*).

Geogr. Distribution.—United States.

This species is distinguished from *St. quadrangulare* Bréb. by its relatively greater length, and its stouter spines, which are also much more divergent.

67. **Staurastrum denticulatum** (Näg.) Arch.

(Pl. CXXXIII, figs. 13–15.)

Phycastrum (Pachyactinium) denticulatum Näg. Gatt. einz. Alg. 1849, p. 128, t. 8, C. f. 3.

Staurastrum denticulatum Arch. in Pritch. Inf. 1861, p. 738 ; Rabenh. Flor. Europ. Alg. 1868, p. 213 ; Kirchn. Alg. Schles. 1878, p. 169 ; Hansg. Prodr. Algenfl. Böhm. 1888, p. 214 ; De Toni, Syll. Alg. 1889, p. 1163 ; West, Alg. N. Wales, 1890, p. 16, f. 27 ; West & G. S. West, Alg. S. England, 1897, p. 493 ; Comp. Study Plankton Irish Lakes, 1906, p. 103 ; Gutwin. Flor. Alg. Mont. Tatr. 1909, p. 470.
Didymidium (Staurastrum) Tigurinum Reinsch, Algenfl. Frank. 1867, p. 161.

Cells small, about as long as broad, or a little shorter, deeply constricted, sinus acute-angled, and opening widely ; semicells subelliptical or fusiform, dorsal margin slightly convex in the middle, ventral margin strongly so ; angles of semicell obtuse and tipped by two minute spines. Cell-wall rough with tiny granules confined to the region of the angles, and arranged in two or three concentric rings around them. Vertical view triangular, sides straight or very slightly concave, angles obtusely rounded.

Zygospore unknown ?

Length 24–35 μ ; breadth 20–40 μ ; breadth of isthmus 7–14 μ.

England.—Plankton of Ennerdale Water and Wast Water, Cumberland! Red Tarn, Hawes Water and Grasmere, Westmoreland ! Epping Forest, Essex ! Worcs !

Wales.—Ffestiniog, Merioneth ! In the plankton !

Ireland.—Munster and Connaught (*Adams*). Plankton of Mayo and Kerry !

Geogr. Distribution.—Germany. Galicia in Austria. Spain. Sweden. Denmark. Finland. Poland. N. Russia Faeroes. Australia. Central Africa. Azores. Colombia. S. America.

This species is distinguished from *St. Avicula* Bréb. by its granulation, there being only two or three series of distinct granules round the angles, and the cells are also proportionately broader.

The zygospore of this species has not hitherto been figured. Amongst some unnamed drawings by the late Professor G. S. West is one, however, which is reproduced on Pl. CXXXIII, fig. 15. This drawing had not been named by Professor West, but it evidently belongs either to *St. denticulatum* or *St. Avicula*. As far as the characters can be seen from the empty semicells in their

present position, the writer is inclined to attribute the figure to *St. denticulatum*.

68. **Staurastrum Avicula** Bréb.

(Pl. CXXXIII, figs. 8–10 and 12.)

Staurastrum Avicula Bréb. in Ralfs, Brit. Desm. 1848, p. 140, t. 23, f. 11; Arch. in Pritch. Infus. 1861, p. 738, t. 3, f. 18, 19; Rabenh. Flor. Europ. Alg. 1868, p. 204; Lund. Desm. Suec. 1871, p. 61; Delp. Desm. sul alp. 1877, p. 165, t. 12, f. 22–29; Turn. Alg. Strensall Common, 1883, p. 80, t. 1, f. 1; Wolle, Desm. U. S. 1884, p. 123, t. 40, f. 30–32; Cooke, Brit. Desm. 1887, p. 145, t. 50, f. 9; De Toni, Syll. Alg. 1889, p. 1153; West, Alg. W. Ireland, 1892, p. 174; Roy & Biss. Scott. Desm. 1893, p. 17, t. 3, f. 11; West & G. S. West, Alg. S. England, 1897, p. 493; G. S. West, Alga-fl. Camb. 1899, p. 25, t. 396, f. 10; West & G. S. West, Alga-fl. Yorks. 1902, p. 97; Alg. N. Ireland, 1902, p. 46; Borge in Botan. Notiser 1913, p. 29; Grönblad, Desm. Keuru, 1920, p. 57, t. 3, f. 36–38.

Cells small, about as long as broad, deeply constricted, sinus variable, usually linear for some little distance, then opening widely; semicells subelliptical or subtriangular, dorsal margin slightly convex, lateral margins sometimes nearly straight, but often very convex; upper angles of semicells furnished with two minute spines, one placed vertically above the other, the dorsal one often slightly longer; cell-wall more or less distinctly rough with minute granules arranged in concentric rows round the angles. Vertical view triangular, sides concave, angles very obtuse, one spine only being visible, as a rule, at each angle.

Zygospore not very well known, but according to Roy, probably globose and furnished with a number of conical spines, very broad at the base and bifurcate at the apex.

Length 29–34·5 μ; breadth, with spines, 35 μ; breadth of isthmus 9–11 μ.

ENGLAND.—Westmoreland! (*Biss.*). W., N., and E. Yorks! Leicester (*Roy*). Cambs! Plankton of Bracebridge Pool, Warwicks! Worcs! Hants! (*Bennett*). Devon! (*Harris*). Cornwall!

WALES.—Capel Curig (*Cooke & Wills*)! Llyn Ogwen and Llyn Bodgynwydd, Carnarvonshire! Ffestiniog, Merioneth!

Scotland.—General! Zygospores from Heughhead, Kincardine (*Roy & Biss.*). Rare in the plankton!

Ireland.—Donegal! Clare Island, Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*). Armagh! Londonderry! Plankton of L. Neagh!

Geogr. Distribution.—France. Germany. Switzerland. Galicia in Austria. Hungary. Servia. Italy. Norway. Finmark. Sweden. Finland. Faeroes. Greenland. Japan. United States and Alaska. Brazil.

St. Avicula is widely distributed, though rarely occurring in abundance. Its uniform granulation and the pair of minute spicules at each angle of the broadly ovate semicells distinguish it. Occasionally one or more of the granules near the angles tend to develop also into short spines.

Var. **subarcuatum** (Wolle) West. (Pl. CXXXIII, fig. 11.)

Staurastrum papillosum Kirchn. Alg. Schles. 1878, p. 170.
St. denticulatum Elf. Anteck. Finska Desm. 1881, p. 9, t. 1, f. 5.
St. subarcuatum Wolle, Desm. U. S. 1884, p. 140, t. 46, f. 15, 16; De Toni, Syll. Alg. 1889, p. 1160.
St. Avicula var. *verrucosum* West, Alg. W. Ireland, 1892, p. 174, t. 23, f. 2.
St. Avicula var. *subarcuatum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 10; Alg. S. England, 1897, p. 493; Alga-fl. Yorks. 1902, p. 98; Alg. N. Ireland, 1902, p. 46; Freshw. Alg. Orkneys and Shetlands, 1905, p. 24; Brit. Freshw. Phytoplankton, 1909, p. 175.

Semicells more distinctly triangular than in the type, dorsal margin nearly straight, sinus more open and acute, angles of cell very slightly produced, membrane distinctly granulate, granules arranged in concentric rows round the angles.

Length 22·5–27 μ; breadth, including spines, 30–37 μ; breadth of isthmus 8·5–10 μ.

England.—Mossdale Moor and Widdale Fell, W. Yorks! Stokesley, N. Yorks! Epping Forest, Essex! New Forest, Hants!

Wales.—In the plankton.

Scotland.—Loch Kinnelan, Ross; Tonley Pond, Aberdeen (*Roy & Biss.*). Plankton of Lochs na Cloiche Sgoilt, Bairness, and na Criche, Inverness! Plankton of Lochs Cuthaig, Fadaghoda, Roinebhall, and Stranabhat,

Lewis, and Loch a Mhorghain, Harris, Outer Hebrides! Orkneys and Shetlands!

IRELAND.—Donegal! Clare Island, Co. Mayo! Galway! Kerry! Armagh! Plankton of Galway!

Geogr. Distribution.—Germany. Finland. India. Australia. United States.

This variety seems to differ from typical *St. Avicula* in the form of its semicells as well as in its stronger granulation. In the front view the semicells are more cuneate, with sides and apex nearly straight, and the angles of the cell are very slightly, almost imperceptibly, produced. In the vertical view the sides are more concave than in the type.

69. **Staurastrum subcruciatum** Cooke & Wills.

(Pl. CXXXIII, figs. 6, 7.)

Staurastrum subcruciatum Cooke & Wills in Cooke, Brit. Desm. 1887, p. 148, t. 51, f. 3; De Toni, Syll. Alg. 1889, p. 1158; Schmidle, Alg. Geb. Oberrheins, 1893, p. 553; West & G. S. West, Alga-fl. Yorks. 1902, p. 97.

Cells a little broader than long, deeply constricted, sinus acute and almost rectangular, opening widely; semicells somewhat triangular or lunate, dorsal margin concave, slightly convex in the middle, ventral margin approximately semicircular, angles slightly produced obliquely upwards and tipped by two diverging spines which lie in the same vertical plane; cell wall covered with tiny granules, which are arranged in concentric series round the angles and are reduced or wanting more remote from them. Vertical view triangular, lateral margins concave and angles slightly produced; centre of apex nearly smooth.

Zygospore unknown.

Length 30–31 μ; breadth 33–35 μ; breadth of isthmus 7·5 μ.

ENGLAND.—Wigton Moor, W. Yorks! Dartmoor, Devon (*Harris*).

WALES.—Capel Curig, Carnarvonshire! (*Cooke & Wills*).

SCOTLAND.—Near Aberdeen!

Geogr. Distribution. — Germany. Austria (form). Servia. Switzerland. Norway.

This species is readily distinguished from *St. Avicula* by its finer granulation, and by the fact that the angles of the semicell are produced to form distinct cylindrical processes. *St. Avicula* var. *subarcuatum* forms, in some ways, a connecting link between the two species. By reason of its almost cylindrical processes, *St. subcruciatum* might well be considered a member of Section I.

Section F.

Cells provided with numerous spines, either clothing the whole surface of the cell-wall, or more or less restricted to the vicinity of the angles.

* Spines few in number or restricted to the vicinity of the angles, semicells sometimes with an apical series of spines as well.

70. *St. pungens.*
71. *St. Simonyi.*
72. *St. cristatum.*
73. *St. oligacanthum.*
74. *St. trachygonum.*
75. *St. spiniferum.*
76. *St. Picum.*
77. *St. horametrum.*

** Spines numerous and more or less distributed over the whole surface of the cell.

† Spines of considerable length and of two very distinct kinds, a few at the angles being considerably stouter than the rest.

78. *St. setigerum.*

†† Spines all more or less similar, or becoming gradually longer towards the angles.

‡ Semicells broadly oval or rhomboidal, cells distinctly longer than broad, with an open sinus.

79. *St. polytrichum.*
80. *St. saxonicum.*
81. *St. cambricum.*
82. *St. echinatum.*

‡‡ Semicells elliptical or subpyramidate-truncate, cells as long as broad, or only a little longer than broad, widest part of the semicell at the base or middle region, never at the apex.

83. *St. gladiosum.*
84. *St. teliferum.*
85. *St. Hystrix.*
86. *St. Brebissonii.*
87. *St. pilosum.*
88. *St. hirsutum.*
89. *St. muricatum.*
90. *St. pyramidatum.*
91. *St. Ravenelii.*

‡‡‡ Semicells narrowly subelliptic, broadest at the apex, which is distinctly flattened.

92. *St. erasum.*
93. *St. erostellum.*

70. **Staurastrum pungens** Bréb.

(Pl. CXXXV, figs. 8–10.)

Staurastrum pungens Bréb. in Ralfs, Brit. Desm. 1848, p. 130, t. 34, f. 10; Arch. in Pritch. Inf. 1861, p. 738; Rabenh. Krypt.-fl. Sachs. 1863, p. 193; Flor. Europ. Alg. 1868, p. 214; Lund. Desm. Suec. 1871, p. 64 (forma); Cooke, Brit. Desm. 1887, p. 144, t. 50, f. 6; Hansg. Prodr. Algenfl. Böhm. 1888, p. 214; De Toni, Syll. Alg. 1889, p. 1148; Heimerl, Desm. Alp. 1891, p. 606; Borge, Süssw. Chlor. Archang. 1894, p. 38; Roy & Biss. Scott. Desm. 1894, p. 24; Comère, Desm. de France, 1901, p. 167, t. 12, f. 24; West & G. S. West, Alg. N. Ireland, 1902, p. 45, t. 2, f. 29; Brit. Freshw. Phytoplankton, 1909, p. 203.

Cells small, about as long as broad, or a little longer, deeply constricted; sinus acute, opening widely; semicells broadly subfusiform or somewhat cuneate, dorsal margin slightly convex, ventral margin very tumid, angles subacute and ending in a strong spine; apex of semicell also provided typically with two accessory spines between each pair of angles, projecting obliquely upwards, but one or other of these may sometimes be reduced or wanting. Vertical view triangular, sides straight or only very slightly concave, angles broadly rounded, tipped with a stout spine, and with two equally strong spines projecting from each lateral margin. Cell-wall minutely punctulate, punctulations arranged in concentric circles round the angles.

Zygospore unknown.

Length, without spines, 26–32·5 μ; breadth, without spines, 26–31 μ; breadth of isthmus 10–11 μ; length of spines about 7 μ.

ENGLAND.—Hampsfell, Lancashire! Cross-in-hand, Sussex (*Ralfs*). Penzance, Cornwall (*Ralfs*).

SCOTLAND.—Aberdeen, Kincardine, Forfar, Perth (*Roy & Biss.*).

IRELAND.—Near Glenties, Donegal! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Hungary. Norway. Sweden. Denmark. Bornholm. Finland. N. Russia. United States.

The semicells of typical specimens of this species possess 9 spines, but irregularities in the number or position of the accessory spines (*i.e.* those not at the angles of the cell) are not infrequent.

71. **Staurastrum Simonyi** Heimerl.

(Pl. CXXXV, figs. 1–4.)

St. Simonyi Heimerl, Desm. alp. 1891, p. 606, t. 5, f. 23; Lütkem. Desm. Millstättersees, 1900, p. 81; Borge, Sao Paulo Süsswasseralgen, 1918, p. 53.

St. Reinschii West, Alg. W. Ireland, 1892, p. 174; West & G. S. West, Alg. S. England, 1897, p. 493; G. S. West, Variation Desm. 1899, p. 392, t. 11, f. 16–20; West & G. S. West, Alga-fl. Yorks. 1902, p. 98; Alg. N. Ireland, 1902, p. 47; Borge, Beiträge Alg. Schweden, 1906, p. 48, t. 3, f. 39.

Cells small, about as long as broad, deeply constricted; sinus acute, widening towards the exterior; semicells usually elliptical or subfusiform, sometimes subsemicircular, dorsal and ventral margins as a rule almost equally convex, lateral angles truncate and provided with 2–4 sharp spines, apical margin with a series of typically 4 spines between each pair of consecutive angles, the two median ones being the largest and projecting conspicuously from the apex, the other two spines sometimes entirely wanting; further with an occasional series of 4 smaller spines beneath the first series. Vertical view triangular, lateral margins straight, slightly concave or even a little convex, angles obtusely rounded

and provided with 2–4 spines, and with a series of 2 or 4 spines just within each lateral margin, the two median ones in the latter case being more conspicuous, lateral margins themselves sometimes provided with a secondary series of 4 spines. Angles occasionally with traces of about two or three concentric series of minute distant denticulations, of which the apical series of spines above-mentioned are well-developed members.

Zygospore unknown ?*

Length, not including spines, 19·5–25 μ ; breadth, not including spines, 18–26 μ ; breadth of isthmus 6–7·5 μ.

ENGLAND.—Westmoreland ! (*Biss.*). Lancashire ! W. and N. Yorks ! Surrey ! Devon (*Bennett*). ? Dartmoor (*Harris*).

WALES.—Capel Curig !, bog below Llyn Idwal !, Llyn-y-cwm-ffynon !, Llyn Teyrn, Snowdon !, and Bettws-y-coed (*Roy*), Carnarvonshire. Ffestiniog, Merioneth !

SCOTLAND.—? General, but scarce !, zygospores from Glen Coe, Argyle (*Roy & Biss.*). Dumfries ! Hoy, Orkneys !

IRELAND.—General in all boggy districts ! Clare Island, Mayo !

Geogr. Distribution.—Austria. Norway. Sweden. ? United States. ? N. W. Canada. Brazil.

There has been much confusion in the past with regard to *St. Simonyi* Heimerl and *St. Reinschii* Roy, but there seems little doubt now that the species recorded by W. & G. S. West from various parts of the British Isles as *St. Reinschii* is in reality *St. Simonyi* Heimerl. Both Dr. Lütkemüller ('Desm. Millstättersees,' 1900, p. 23) and Dr. Borge ('Sao Paulo Süsswasseralgen," p. 53) have pointed out this fact, and the writer believes that, before his death, Professor West was in agreement with the two continental algologists on this point. Whether or not *St. Reinschii* Roy (= *Staurastrum* sp. Reinsch, 'Contrib. ad Alg. Fung.' 1875, t. 17, f. 5) has actually been seen from the British Isles is somewhat doubtful. Roy's first remarks on the subject

* The Desmid recorded by Roy & Biss. ('Scott. Desm.' 1894, p. 24) as *St. Reinschii* with zygospores is possibly *St. Simonyi* Heimerl. The authors give neither description nor figure.

('Desm. Perthshire,' 1877, p. 5 (sep.)) that his Desmid "nearly" agreed with the figure of Reinsch lead one to understand that the Scottish specimens were not *identical* with those of Reinsch, and were perhaps more in agreement with Heimerl's later described species. Roy also records a Desmid under the name of *St. Reinschii* from Mull, and with zygospores from Glen Coe. In no case, however, are figures given. Thus, in view of the fact that Roy himself states that the specimens originally seen by him were not absolutely identical with Reinsch's figures, the writer is inclined to think that whether or not *St. Reinschii* Roy actually exists as a valid species, all British specimens at any rate recorded under that name have in all probability belonged to *St. Simonyi* Heimerl. Until a Desmid complying with Reinsch's figure and description has been accurately figured, therefore, *St. Reinschii* Roy has provisionally been omitted from the British list. The matter is further complicated by the fact that both Cooke (' Brit. Desm.' 1887) and De Toni (' Syll. Alg.' 1889) have in their descriptions of *St. Reinschii* united the characters of two of Reinsch's species, those figured in ' Contrib. Alg. Fung.' 1875, t. 17, figs. 4 and 5 respectively. These are two distinct species according to Reinsch, and fig. 5 only represents *St. Reinschii*.

72. **Staurastrum cristatum** (Näg.) Arch.

(Pl. CXXXIX, fig. 5.)

Phycastrum (Pachyactinium) cristatum Näg. Gatt. einz. Alg. 1849, p. 127, t. 8, C. f. 1.
Staurastrum nitidum Arch. in Quart. Journ. Micr. Sci. 1860, p. 78, t. 7, f. 3, 4; Rabenh. Krypt.-fl. Sachs. 1863, p. 193.
St. cristatum Arch. in Pritch. Infus. 1861, p. 738; Rabenh. Flor. Europ. Alg. 1868, p. 215; Nordst. Desm. Spetsb. 1872, p. 40; Jacobs. Desm. Danemark, 1875, p. 208, t. 8, f. 25; Kirchn. Alg. Schles. 1878, p. 170; Cooke, Brit. Desm. 1887, p. 144, t. 50, f. 7; Hansgirg, Prodr. Algenfl. Böhm. 1888, p. 215; De Toni, Syll. Alg. 1889, p. 1148; Borge, Bidr. Sibir. Chlor. 1891, p. 10; West, Alg. W. Ireland, 1892, p. 173, t. 22, f. 16; Alg. Engl. Lake Distr. 1892, p. 18; Roy & Biss. Scott. Desm. 1893, p. 19; Börg. Alg. Faeroes, 1901, p. 233; Comère, Desm. de France, 1901, p. 167, t. 13, f. 20; West & G. S. West, Alga-fl. Yorks. 1902, p. 98; Kaiser, Algenfl. Traunstein u. Chiemgau, II, 1914, p. 158.
Didymidium Naegelianum Reinsch, Algenfl. Frank. 1867, p. 167.
Staurastrum Nordstedtii Gutw. Wahr. d. Priorität, 1890, p. 72; Flor. Glon. Okol. Llowa, 1891, p. 71, t. 3, f. 22.

Cells small, about as long as broad, excluding the spines, constriction fairly deep, sinus acute, opening

widely; semicells broadly elliptical, dorsal margin slightly convex, sometimes rather flattened on the summit, ventral margin very convex, lateral angles sometimes slightly mamillate, furnished with a short spine directed obliquely outwards, and with about 2 pairs of spines projecting from the apical margin of each angle. Vertical view usually triangular, sides straight, angles acutely rounded, ending in a short spine, and with about 2 or 3 pairs of short spines on the apex in each angle, directed outwards; cell-wall punctate.

Zygospore unknown.

Length, without spines, 36–39 μ; breadth, without spines, 32–45 μ; breadth of isthmus 15–19 μ.

England.—Hawkshead and Hampsfell, Lancashire! Strensall Common (*W. B. Turner*) and Pilmoor, N. Yorks! Dartmoor, Devon (*Harris*). Cornwall (*Marquand*).

Wales.—Capel Curig (*Cooke & Wills*) and Snowdon (*Roy*).

Scotland.—Sutherland, Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Argyle, Fife (*Roy & Biss.*).

Ireland.—Small lakes, Clifden to Roundstone, and Derryclare Lough, Co. Galway! Glengariff and Carrantuohill, Co. Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Galicia and Austria. Hungary. Norway. Finmark. Sweden. Denmark. Bornholm. N. Russia. Faeroes. Spitzbergen Greenland. Siberia. Japan. India. Turkey-in-Asia.

73. **Staurastrum oligacanthum** Bréb.

(Pl. CXXXIX, fig. 6.)

St. oligacanthum Bréb. Arch. in Quart. Journ. Micr. Sci. 1866, p. 67 and p. 189; Nordst. Desm. Arctoæ, 1875, p. 36, t. 8, f. 39; Cooke, Brit. Desm. 1887, p. 145, t. 50, f. 8; De Toni, Syll. Alg. 1889, p. 1149; Roy & Biss. Scott. Desm. 1893, p. 23; West & G. S. West, Alga-fl. Yorks. 1901, p. 98; Comère, Desm. de France, 1901, p. 168, t. 12, f. 18.

Cells small, about as long as broad, constriction fairly deep, sinus acute, almost rectangular; semicells depressed hexagonal, apex truncate, lateral angles acute and terminating in a conspicuous spine which is fre-

quently emarginate or compound; lateral margins provided with a series of spines extending from the angle of the truncate apex nearly to the sinus, and with a few spines just within each angle. Vertical view with the lateral margins distinctly concave, angles acute, terminating in a sharp spine, and surrounded by one or two concentric series of spines, with a pair of spines at the base of each angle; centre of apex smooth. Spines often becoming emarginate.

Zygospore unknown.

Length about 44 μ; breadth about 52 μ; breadth of isthmus 25 μ.

ENGLAND.—Risley Bog, Lancashire (*Roy*). Mickle Fell, N. Yorks! Enbridge Lake and Woolton Pond, Hants (*Roy*). Dartmoor, Devon (*Harris*).

WALES.—Bettws-y-coed (*Roy*) and Capel Curig!, Carnarvonshire.

SCOTLAND.—Near Brin, Inverness; near Cambus O'May and Tomachar, Aberdeen; near Loch Clunie, Perth (*Roy & Biss*).

IRELAND.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Switzerland. Galicia in Austria. Norway. Spitzbergen. Greenland (form).

St. oligacanthum is very closely allied to the preceding species, with which it has probably been frequently confused by many workers. As Archer (in 'Q. J. M. S.' vol. 6, 1866, p. 189) points out, there are, however, distinct differences. In *St. cristatum* the semicells are elliptic fusiform, both ventral and dorsal margins are convex, and there is a mucronate angle on each side (usually submamillate). In *St. oligacanthum* the semicells are angular and roughly hexagonal with a markedly truncate apex. In the vertical view the lateral margins of *St. cristatum* are slightly convex, but in *St. oligacanthum* distinctly concave.

Var. **incisum** West. (Pl. CXXXIX, fig. 7.)

Staurastrum oligacanthum var. *incisum* West, Alg. W. Ireland, 1892, p. 173, t. 22, f. 17.

Semicells with a distinct incision in the lower lateral margins; vertical view triangular with slightly convex margins.

Length 39 μ; breadth 40 μ; breadth of isthmus 22·5 μ.

IRELAND.—In small lakes, Clifden to Roundstone, Galway!

74. **Staurastrum trachygonum** West.

(Pl. CXXXIX, fig. 3.)

St. trachygonum West, Alg. W. Ireland, 1892, p. 176, t. 23, f. 5.

Cells small, a little longer than broad, constriction moderately deep, sinus fairly open; semicells subelliptical, apex truncate, cells provided with spines, some of which are truncate, round the angles and on the apex; in vertical view triangular, sides very slightly concave, angles rounded, the smooth apex provided with a circle of short spines.

Zygospore unknown.

Length 32·5 μ; breadth 28 μ; breadth of isthmus 7·5 μ.

IRELAND.—Kylemore, Co. Galway!

75. **Staurastrum spiniferum** West.

(Pl. CXXXIV, fig. 7.)

St. spiniferum West, Alg. N. Wales, 1890, p. 16, f. 20: Freshw. Alg. Maine, II, 1891, p. 3; West & G. S. West, Brit. Freshw. Phytoplankt. 1909, p. 202.

Cells small, slightly longer than broad, deeply constricted, sinus open and acute; semicells elliptical, with about 8 spines round the periphery of each. Vertical view triangular, sides very slightly concave, with a spine at each angle and two others projecting from each side, and with two or three scattered spines also on the apex.

Zygospore unknown.

Length, without spines, 25 μ; breadth, without spines, 22 μ; breadth of isthmus 7·5 μ; length of spines about 5 μ.

WALES.—Ffestiniog, Merioneth!

Geogr. Distribution.—United States.

76. **Staurastrum Picum** W. & G. S. West.
(Pl. CXXXVII, fig. 8.)

Staurastrum Picum West & G. S. West, New and Int. Freshw. Alg. 1896, p. 159, t. 4, f. 49; Brit. Freshw. Phytoplankton, 1909, p. 202.

Cells small, a little broader than long, deeply constricted, sinus open and subacuminate; semicells elliptic-fusiform, angles somewhat inflexed and subcapitate, each with a single strong spine, slightly curved and strongly inflexed; dorsal margin provided with about 6 paired spines which are short and curved; vertical view triangular, angles obtuse and subcapitate, sides slightly concave, with about 6 paired spines along each; cell-wall smooth.

Zygospore unknown.

Length, without spines, 20 μ; with spines, 25 μ; breadth without spines, 23–26 μ; with spines, 29–34 μ; breadth of isthmus 8 μ.

Ireland.—Glen Caragh, Co. Kerry!

77. **Staurastrum horametrum** Roy & Biss.
(Pl. CXXXIX, fig. 4.)

St. horametrum Roy & Biss. Scott. Desm. 1893, p. 21, t. 3, f. 2; Gutw. Nonn. Alg. Nov. 1896, p. 60, t. 7, f. 72.

Cells medium sized, a little longer than broad, "hourglass" shaped, constriction opening rectangularly, sides about straight; semicells widening upwards, angles subacute, ends flatly convex; angles with 3 or 4 rows of crowded, short, simple, acute, stout spines; end view triangular or quadrangular, sides slightly concave, angles acutely rounded, very spiny, 2 or 3 rows of spines across the angles, and a circle of 15 spines around the centre in the triangular form, and of 20 in the quadrangular. Isthmus about half the thickness of the semicell. Membrane smooth (*Roy & Biss.*).

Zygospore unknown.

Length about 57–65 μ; breadth 48–59 μ; breadth of isthmus 18–24 μ.

Scotland.—Powlair, Slewdrum, Heughhead, Birkhill, Tomachar, Dinnet, Glen Clunie, Aberdeen; near Crathes, and near Durris Bridge, Kincardine; Glen Isla, Forfar (*Roy & Biss.*).

Geogr. Distribution.—Galicia in Austria. Faeroes.

This species is nearest to *St. asperum* Bréb. in the form of its semicells, but the arrangement of the spines, which are almost entirely confined to the angles, distinguishes it.

78. **Staurastrum setigerum** Cleve.

(Pl. CXXXVI, figs. 13, 14.)

St. setigerum Cleve, Sverig. Desm. 1864, p. 490, t. 4, f. 4; Rabenh. Flor. Europ. Alg. 1868, p. 216; Nordst. Norges Desm. 1873, p. 31; Wolle, Desm. U. S. 1884, p. 141, t. 45, f. 26, 27; De Toni, Syll. Alg. 1889, p. 1168; Roy & Biss. Scott. Desm. 1894, p. 25, t. 3, f. 9; Eichler, Mat. Flor. Miedz. 1894, p. 62; Comère, Desm. de France, 1901, p. 167, t. 12, f. 2; Borge, Alg. erst. Regnell. Exped. II, Desm. 1903, p. 108; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 202; Borge, Sao Paulo Süsswasseralgen, 1918, p. 53.

St. Royanum Arch. in Quart. Journ. Micr. Sci. 1877, vol. 17, p. 103; Cooke, Brit. Desm. 1887, p. 152.

Cells of medium size, a little longer than broad, deeply constricted, sinus acute and open; semicells elliptical, ventral margin more convex than the dorsal, angles obtusely rounded and provided with 2–5 (usually 3) long stout spines arranged in a vertical row, or sometimes (according to Archer) in a circle like the shafts of a shuttlecock. Surface of cell provided with a number of long but more delicate spines than those at the angles, arranged in distant obscure circles round the angles. Vertical view triangular, sides nearly straight, angles rather acutely rounded. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore unknown.

Length, without spines, 50–56 μ; breadth, without spines, 42–45 μ; breadth of isthmus 14·5–17 μ; length of angular spines 15–20 μ; length of more delicate spines about 10–12 μ.

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Glen Coe, Argyle (*Arch.*). Rhiconich, Sutherland! Near Tarbert, Harris, Outer Hebrides!

Ireland.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Norway. Sweden. Finland. Poland. Central Africa. United States. N. W. Canada. Brazil. Paraguay.

St. setigerum is distinguished from all other spiny species of *Staurastrum* by the possession of two distinct kinds of spines, the stout angular spines contrasting strongly with those on the faces of the semicell, which are much more delicate.

79. **Staurastrum polytrichum** (Perty) Rabenh.

(Pl. CXXXVI, figs. 8–10.)

Phycastrum polytrichum Perty, Kleinst. Lebensf. 1852, p. 210, t. 16, f. 24.
Staurastrum Pringsheimii Reinsch, Spec. Gen. Alg. 1867, p. 22, t. 5, A, B. f. 1–8; Arch. in Journ. Bot. 1874, p. 93; Reinsch, Contr. Alg. Fung. 1875, p. 90, t. 10, f. 4; Cooke, Brit. Desm. 1887, p. 152, t. 52, f. 4; Espensch. Desm. berg. Landes, 1903, p. 103, t. 2, f. 19.
St. polytrichum Rabenh. Flor. Europ. Alg. 1868, p. 214; Lund. Desm. Suec. 1871, p. 63; Nordst. Norges Desm. 1873, p. 30; De Toni, Syll. Alg. 1889, p. 1169; Racib. Desmidyja Ciastonia, 1892, p. 389; West, Alg. W. Ireland, 1892, p. 175, t. 22, f. 18; Roy & Biss. Scott. Desm. 1893, p. 23, t. 3, f. 8; Turn. Freshw. Alg. E. India, 1893, p. 113, t. 13, f. 16; West & G. S. West, Alg. S. England, 1897, p. 494; Gutw. Wykaz Glonow Wadow.-Makow. 1897, p. 158; Schmidle, Lappmark Süsswasseralgen, 1898, p. 54; Lütkem. Desm. Millstättersees, 1900, p. 23; West & G. S. West, Alga-fl. Yorks. 1902, p. 99; Alg. N. Ireland, 1902, p. 48; Scott. Freshw. Plankt. 1, 1903, p. 529; Hirn, Desm. Finnland, 1903, p. 22; G. S. West, Brit. Freshw. Alg. 1904, p. 172, f. 65 D; Cushman in Bull. Torr. Bot. Club, 1905, p. 228, t. 8, f. 18 (var.).
St. Pringsheimii var. *duplo-major* Turn. New Rare Desm. 1885, p. 939, t. 16, f. 24.
St. teliferum var. *convexum* Benn. Alg. Engl. Lake Distr. 1886, p. 11, t. 2, f. 21–23.

Cells of medium size, about $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus acute and sometimes fairly open; semicells elliptical or subelliptical, cell-wall covered with fairly long acute spines, arranged in obscure circles round the angles, and sometimes visible as longitudinal rows on the faces. Vertical view triangular, sides straight or almost imperceptibly concave, angles somewhat obtusely rounded, spines becoming shorter towards the centre of the apex, which is quite smooth.

Zygospore of type unknown.*

Length, without spines, 48–67 μ; with spines, 54–80 μ; breadth, without spines, 41–48 μ; with spines, 50–70 μ; breadth of isthmus 15–22 μ; length of spines 5–11 μ; diam. zygosp. (var.) without spines, 53 μ; with spines, 78 μ.

ENGLAND.—Westmoreland! (*Biss.*). W. and N. Yorks! Warwicks! Surrey! Hants! Devon (*Bennett*, *Harris*). Cornwall (*Bennett*).

WALES.—Llyn Padarn, Llyn Idwal, Llyn Gwynant, Capel Curig! (*Cooke & Wills*) and Snowdon (*Roy*), Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth!, Argyle, Wigtown (*Roy & Biss.*). Plankton of Loch Shin, Sutherland!

IRELAND.—Lough Anna, Donegal! Clare Island, Co. Mayo! Small lakes, Clifden to Roundstone, Co. Galway! Cloonee Lough, Co. Kerry! Dublin and Wicklow (*Arch.*). Stream, N. of Newcastle, Co. Down!

Geogr. Distribution.—Germany. Switzerland. Galicia and Austria. Norway. Sweden. Finland. S. Russia. India. United States. N. W. Canada. Argentine.

This species is one of the most beautiful of the spiny *Staurastra*. It is distinguished from *St. gladiosum* Turn. by its greater size and relatively greater length, and by the uniform character and regular arrangement of its more numerous spines.

80. **Staurastrum Saxonicum** Bulnh.

(Pl. CXXXVII, fig. 7.)

Staurastrum sp. Bulnh. Einige Desm. 1859, p. 22, t. 2, f. 7.
St. Saxonicum Bulnh. in Rabenh. Krypt.-flor. Sachs. 1863, p. 190: Rabenh. Flor. Europ. Alg. 1868, p. 213: Nordst. Desm. Spetsb. 1872, p. 40: Desm. Arct. 1875, p. 35; Boldt, Desm. Grönland, 1888, p. 36; De Toni, Syll. Alg. 1889, p. 1173: Börg. Desm. Brasil, 1890, p. 949; Roy & Biss. Scott. Desm. 1893, p. 25, t. 3. f. 10: West & G. S. West, Alg. S. England, 1897, p. 494: Alga-fl. Yorks. 1902, p. 99; Cushman in Rhodora, 1903, p. 222.

* The zygospore of *St. polytrichum* var. *readingense* Cushman has been described in 'Bull. Torr. Bot. Club,' 1905, p. 228. In general form it is spherical, and it is thickly beset with peculiar spines which are very broad at the base; at the apex they are first trifurcate and then bifid. The whole zygospore including the spines is thickly covered with irregular elongated granules. It is a very extraordinary zygospore (see Pl. CXXXVI, f. 11).

? *St. Notarisii* Delp. Spec. Desm. subalp. 1877, p. 157, t. 13, f. 1–2.
? *St. bullosum* Benn. Freshw. Alg. Engl. Lake Distr. 1886, p. 11, t. 2, f. 18–20; Cooke, Brit. Freshw. Alg. 1887, p. 152, t. 51, f. 5; De Toni, Syll. Alg. 1889, p. 1170.

Cells of rather more than medium size, about $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus acute, opening widely; semicells broadly oval, angles very obtusely rounded; cell-wall closely covered with numerous short acute spines, evenly distributed except that they are wanting in the centre of the apex of the semicell. Vertical view 3- (rarely 4- or 5-) angular, sides very slightly convex, angles bluntly rounded. Cell-wall minutely punctate.

Zygospore unknown.

Length, without spines, 77–79 μ; with spines, 85–86 μ; breadth, without spines, 58–65 μ; with spines, 72–74 μ; breadth of isthmus, 21–22 μ; length of spines 3–8 μ.

England.—Loughrigg, Westmoreland (*Bennett*). Denholme, Cam Fell and near Brickden, W. Yorks! New Forest, Hants! Dartmoor, Devonshire (*Harris*).

Scotland.—Near Mill of Maidencraig, Haughton, Tillyfour, below Aboyne, Dinnet, Koynach Moor in Cromar, Castleton, Braemar, Aberdeen; near Durris Bridge, Cammie, Dalbrake, Slack of Birnie, Kincardine; Lundie Bog, Easter Ogil in Fern, Forfar (*Roy & Biss.*). Plankton of Loch Trebister, Shetlands!

Geogr. Distribution.—France. Germany. Galicia and Austria. Italy. Norway. Sweden. Bornholm. Nova Zembla. Spitzbergen. Greenland. United States. Brazil.

St. Saxonicum is distinguished from *St. polytrichum* by the form of its semicells, which are relatively longer and more broadly oval, and its shorter spines are also more numerous.

81. **Staurastrum cumbricum** West.

(Pl. CXXXVII, figs. 13, 14.)

St. cumbricum West, Alg. N. Wales, 1890, p. 16, t. 5 f. 5, t. 6, f. 36.

Cells rather large, $1\frac{1}{3}$ times longer than broad, deeply

constricted, sinus open, almost rectangular; semicells broadly elliptical; cell-wall beset with spines of varying lengths, the longest being arranged at the angles. Vertical view triangular with slightly convex sides. Chloroplast axile with a central pyrenoid in each semicell.

Zygospore unknown.

Length 76–85 μ; breadth 55–65 μ; breadth of isthmus 25 μ; length of spines at angles 11–15 μ.

England.—Lindeth, Westmoreland!

Wales.—Capel Curig, Carnarvonshire!

This species differs from *St. polytrichum* in its larger size and in its relatively sharper spines of varying lengths. *St. Saxonicum* differs in its shorter uniform spines.

Var. **cambricum** West. (Pl. CXXXVII, figs. 15, 16.)

St. cumbricum var. *cambricum* West, Alg. N. Wales, 1890, p. 17, t. 5, f. 6, t. 6, f. 37.

Differs from the type in its narrower isthmus and somewhat rhomboidal form of the semicells.

Length 62–83 μ; breadth 48–64 μ; breadth of isthmus 13–20 μ.

Wales.—Capel Curig, Carnarvonshire!

82. **Staurastrum echinatum** Bréb.
(Pl. CXXXVII, fig. 12.)

St. echinatum Bréb. in Ralfs, Brit. Desm. 1848, p. 215, t. 35, f. 24; Arch. in Pritch. Inf. 1861, p. 739; Rabenh. Flor. Europ. Alg. 1868, p. 213; Kirchn. Alg. Schles. 1878, p. 166; Wolle, Desm. U.S. 1884, p. 141, t. 45, f. 31. 32 (fig. not accurate); Hansg. Prodr. Algenfl. Böhm. 1888, p. 214; West, Desm. Maine, 1888, p. 340; De Toni, Syll. Alg. 1889, p. 1171; Turn. Freshw. Alg. E. India, 1893, p. 112, t. 16, f. 48; Roy & Biss. Scott. Desm. 1894, p. 19; Comère, Desm. de France, 1901, p. 172, t. 12, f. 22; ? West & G. S. West, Freshw. Chlorophy. Koh Chang, 1901, p. 177, t. 3, f. 31 (forma); Cushman in Rhodora, 1903, p. 224 and 253; ? G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 125 (forma); Borge, Botan. Notiser, 1913, p. 49, t. 3, f. 36.

Cells small, slightly longer than broad, deeply constricted, sinus open and acute-angled; semicells broadly elliptical, angles rounded; cell-wall covered with rather short spines, which are considerably dilated at the base,

arranged in horizontal and vertical series across the faces of the semicell. Vertical view triangular, sides straight or slightly convex, each with about 8 spines along the margin; apex of semicell provided with 2 or 3 series of spines parallel to the marginal one, centre of apex smooth.

Zygospore unknown.*

Length 33 μ; breadth 28 μ; breadth of isthmus 12·5 μ; length of spines about 2·5 μ.

WALES.—Capel Curig, Carnarvonshire (*Roy*).

SCOTLAND.—Very rare; near New Pitsligo, and South of Birsemore, Aberdeen; Canlochan, Forfar; Bracklin, Perth (*Roy & Biss.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia in Austria. Servia. Norway. Sweden (form). Poland. Central Russia. Faeroes. Greenland. ? India. ? Siam. E. and Central Africa. United States. Alaska.

Fig. 12, Pl. CXXXVII, is copied from a drawing by the late Dr. Lütkemüller made by him from de Brébisson's original exsiccata. It certainly agrees more with de Brébisson's figure in Ralfs' 'British Desmidieæ' than any other figure previously published. *St. echinatum* had never been observed in Britain by either the late Professor G. S. West or W. West, and the figures published by them of specimens from Koh Chang and Africa obviously deviate considerably from the type, and were only referred to this species after much deliberation. They would possibly be more correctly placed in some other species. A very characteristic feature of *St. echinatum* is the peculiar and sudden dilatation of the spines at their base (see in this connection the figure of Borge in 'Botan. Notiser,' 1913, t. 3, f. 36, which also gives some indication of this character).

83. **Staurastrum gladiosum** Turn.
(Pl. CXXXVII, figs. 1, 2.)

St. gladiosum Turn. New Rare Desm. 1885, p. 6, t. 16, f. 21; De Toni, Syll. Alg. 1889, p. 1172; West, Alg. N. Wales, 1890, p. 16, West & G. S. West, Alg. S. England, 1897, p. 494.

* Grönblad ('Desm. Keuru,' 1920, p. 62, t. 1, f. 38–40) figures a *Staurastrum* with zygospore which he refers with some doubt to *St. echinatum* Bréb. In the opinion of the writer this Desmid does not belong here, since the spines are far too long. The zygospore has therefore been ignored.

Cells rather under medium size, about as long as broad. sinus acute and not very widely open; semicells elliptic-reniform, dorsal and ventral margins almost equally convex, cell wall uniformly covered with stout spines, about 14–20 visible along the peripheral margin, arranged in obscure circles round the angles, and more or less scattered further away. Vertical view triangular, sides slightly concave, angles broadly rounded, about 9 spines visible along each lateral margin, spines in the centre of the apex sparsely scattered.

Zygospore unknown.

Length, without spines, 37·5–41 μ; with spines, 47·5–51 μ; breadth, without spines, 37·5–40 μ; with spines, 48–50 μ; breadth of isthmus 11–12 μ.

ENGLAND.—Gunwen Moor, Cornwall!

WALES.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—India (var.). United States.

Var. **delicatulum** W. & G. S. West. (Pl. CXXXVII, fig. 3.)

St. gladiosum var. *delicatulum* West & G. S. West, Notes Algæ, II, 1900, p. 296, t. 1, f. 14; Alga-fl. Yorks. 1902, p. 99.

A variety with more delicate spines, which are sometimes slightly curved, and are far less numerous more remote from the angles.

Length, without spines, 37·5 μ; with spines, 44 μ; breadth, without spines, 38·5 μ; with spines, 50 μ; breadth of isthmus, 14 μ.

ENGLAND.—Malham Tarn, W. Yorks!

The form of the cell in this variety, also the number and length of the spines, are nearer to those of *St. gladiosum* than any other species. The semicells are more depressed than in *St. teliferum*, and the spines are longer and more delicate.

84. **Staurastrum teliferum** Ralfs.

(Pl. CXXXVI, figs. 2–6.)

St. teliferum Ralfs. Brit. Desm. 1848, p. 128, t. 22, f. 4, t. 34, f. 14; Arch. in Pritch. Inf. 1861, p. 739, t. 3, f. 20–21; Rabenh. Krypt.-fl. Sachs. 1863 p. 190; De Not. Desm. Ital. 1867, p. 50, t. 4, f. 40; Rabenh. Flor. Europ

Alg. 1868, p. 212; Nordst. Norges Desm. 1873, p. 30; Delp. Desm. subalp. 1877, p. 148, t. 11, f. 1–4; Kirchn. Alg. Schles. 1878, p. 170; Gay, Monogr. loc. Conj. 1884, p. 68; Wolle, Desm. U. S. 1884, p. 140, t. 45, f. 4; Cooke, Brit. Desm. 1887, p. 151, t. 52, f. 2; Boldt, Desmid. Grönland, 1888, p. 36; West, Desm. Mass. 1889, p. 5; De Toni, Syll. Alg. 1889, p. 1167; Anderss. Sverig. Chlor. 1890, p. 12; West, Alg. W. Ireland, 1892, p. 175, t. 24, f. 5; Alg. Eng. Lake Distr. 1892, p. 19; Lütkem. Desm. Attersees, 1893, p. 564; Roy & Biss. Scott. Desm. 1894, p. 26; West & G. S. West, Alg. S. England, 1897, p. 493; Comère, Desm. de France, 1901, p. 171, t. 12, f. 17; West & G. S. West, Alga-fl. Yorks. 1902, p. 99; Alg. N. Ireland, 1902, p. 48; Schröder, Gallertbildung Alg. 1902, p. 163, t. 7, f. 14; Teodoresco, Matér. flor. Alg. Rouman. 1907, p. 184; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 175; Kaiser, Beitr. Algenfl. Traunstein u. Chiemgau, 1914, p. 153.

Didymidium Hystrix B. *majus* Reinsch, Algenfl. Frank. 1867, p. 171.

Staurastrum polytrichum var. *alpinum* Schmidle, Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald, 1895, p. 81, t. 1, f. 20.

Xanthidium homœacanthum Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 17, t. 1, f. 4.

Cells rather under medium size, about $1\frac{1}{5}$ times longer than broad, deeply constricted, sinus acute and open; semicells elliptical, with the angles broadly rounded; cells provided with a number of short stout spines, arranged chiefly at the angles, with a few sparsely scattered on the faces. End view triangular, sides somewhat concave, angles broadly rounded, spines more numerous at the angles and almost wanting in the middle of the lateral margins. Chloroplast axile, with a central pyrenoid in each semicell, and a pair of lobes extending into each angle.

Zygospore orbicular, provided with a number of long stout spines, forked at the apex.

Length, without spines, 32–56 μ; with spines, 40–64 μ; breadth, without spines, 27–37 μ; with spines, 40–45 μ; breadth of isthmus 8–10 μ; diam. zygosp., without spines, 27·5 μ; length of spines 15 μ.

England.—Plankton of Codale Tarn and Easedale Tarn, Cumberland! Westmoreland and in the plankton of Ennerdale Water! Lancashire! W., N., and E. Yorks! Cheshire (*Roy*). Berks (*Griffiths*). Burnham Beeches, Bucks! Surrey! Sussex (*Ralfs*). Hants! Wilts! Devon! (*Harris, Bennett*). Cornwall!

Wales.—General! (At 2200 feet on Glyder Fach). In the plankton!

Scotland.—General, occasionally with zygospores (*Roy & Biss.*). Rare in the plankton! Lewis and Harris, Outer Hebrides! Orkneys and Shetlands, and in the plankton!

Ireland.—General; zygospores from near Roundstone, Co. Galway! Clare Island!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Servia. Roumania. Italy. Norway. Sweden. Denmark. Bornholm. Finland. N. and S. Russia. Faeroes. Iceland. Greenland. Siberia. Central China (var.). Japan. Burma. Azores. United States. Brazil.

This is one of the most widely distributed of the British Desmids, and is frequent in nearly all bog collections. The form described by Bennett ('Alg. Engl. Lakes,' 1886, p. 11, t. 2, f. 21 and 22) as *St. teliferum* var. *convexum* does not belong to this species, but is more probably a form of *St. polytrichum* Perty.

Forma **obtusa** West. (Pl. CXXXVI, fig. 7.)

St. teliferum forma *obtusa* West, Alg. W. Ireland, 1892, p. 175, t. 24, f. 6.

A form in which the spines are reduced to very short obtuse nodules.

Length, without spines, 45 μ; with spines, 50 μ; breadth, without spines, 39 μ; with spines, 45 μ; breadth of isthmus 12·5 μ.

Ireland.—Small Lakes, Clifden to Roundstone, Co. Galway!

85. **Staurastrum Hystrix** Ralfs.

(Pl. CXXXVI, fig. 1.)

St. Hystrix Ralfs, Brit. Desm. 1848, p. 128, t. 22, f. 5: Arch. in Pritch. Infus. 1861, p. 739; Rabenh. Flor. Europ. Alg. 1868, p. 213; Wolle, Desm. U. S. 1884, p. 142, t. 45, f. 14–16; Cooke, Brit. Desm. 1887, p. 151, t. 52, f. 3; De Toni, Syll. Alg. 1889, p. 1167; West, Alg. Engl. Lake Distr. 1892, p. 19; Roy & Biss. Scott. Desm. 1893, p. 21; Schmidle, Beitr. Alp. Alg. 1895, p. 31; West & G. S. West, Alg. S. England, 1897, p. 493; Comère, Desm. de France, 1901, p. 171, t. 13, f. 9; Espenscheid, Alg. berg. Landes, 1903, p. 103, t. 2, f. 20.

Didymidium (Staurastrum) Hystrix A. *minus* a *trigonum* Reinsch, Algenfl. Frank. 1867, p. 171.

Cells small, about $1\frac{1}{4}$ to $1\frac{1}{3}$ times longer than broad, deeply constricted, sinus narrow and acute; semicells elliptic-oblong, dorsal margin somewhat flattened, angles very bluntly rounded, with 2 or 3 scattered spines and about 6 or 8 others arranged in a circle just beneath. Vertical view triangular, rarely quadrangular, lateral margins slightly concave, angles obtusely rounded; spines confined to the region of the angles. Cell-wall smooth.

Zygospore unknown.

Length, without spines, 25 μ; breadth, without spines, 21 μ; breadth of isthmus 6·5 μ; length of spines 3–4 μ.

ENGLAND.—Brother's Water, Westmoreland! Ditton Common, near Devil's Jumps, and Thursley Common, Surrey! Near Storrington, Sussex (*Ralfs*). Dartmoor, Devon (*Harris*).

WALES.—Capel Curig, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Sutherland, Inverness, Aberdeen, Forfar, Perth, Argyle, Arran (*Roy & Biss.*). Near Balallan, Lewis, and Tarbert, Harris, Outer Hebrides!

IRELAND.—Ballynahinch, Galway! Leinster (*Adams*). Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Austria (var.). Hungary. Norway. Sweden. Poland. United States. Brazil.

This species is very similar to *St. teliferum* Ralfs, but is readily distinguished from that species not only by its smaller size and the more restricted arrangement of the spines, but also in the form of the semicells, which are elliptic oblong and more depressed than those of *St. teliferum*.

86. **Staurastrum Brebissonii** Arch.

(Pl. CXXXVII, figs. 4, 5.)

Staurastrum pilosum Bréb. Liste Desm. 1856, p. 141, t. 2, f. 49; Cleve, Sverig. Desm. 1863, p. 490, t. 4, f. 3.

St. Brebissonii Arch. in Pritch. Inf. 1861, p. 739; Lund. Desm. Suec. 1871, p. 63; Nordst. Desm. Spetsb. 1872, p. 133; Desm. Arctoæ, 1875, p. 34; Wolle, Desm. U.S. 1884, p. 141, t. 45, f. 5, 6; Cooke, Brit. Desm. 1887,

p. 150, t. 52, f. 6; De Toni, Syll. Alg. 1889, p. 1166; Gutwin. Flor. glonów Galic. 1892, p. 73; Roy & Biss. Scott. Desm. 1893, p. 18; Lütkem. Desm. Millstättersees, 1900, p. 22; Comère, Desm. de France, 1901, p. 171, t. 12, f. 6; W. & G. S. West, Alg. N. Ireland, 1902, p. 48.
St. pilosum b. Brebissonii, Rabenh. Flor. Europ. Alg. 1868, p. 212.

Cells small, about as long as broad, or sometimes not quite as long as broad, deeply constricted, sinus acute, widening outwards; semicells elliptical or elliptic-fusiform, angles rather acutely rounded, cell-wall provided with numerous fine, acute spines, which are more crowded and longer near the angles, around which they are arranged in concentric circles. Spines in front view of semicell arranged in longitudinal rows, becoming smaller and more distant towards the centre of the face. Vertical view usually 3- (–5-) angular, sides distinctly concave, angles acutely rounded, spines wanting in the centre of apex.

Zygospore according to Cleve's figure spherical with numerous complex spines.

Length, without spines, 34–48 μ; breadth, without spines, 40–62 μ; breadth of isthmus 13 μ; length of spines at the angles about 2·5 μ; diam. zygosp. 72 μ.

England.—Near Bowness, Westmoreland (*Bissett*). Leicestershire (*Roy*). Sutton Park and Harborne, Warwicks! Hants (*Roy*).

Wales.—Capel Curig and Glyder Fach (at 2200 feet), Carnarvonshire!

Scotland.—Ross, Aberdeen, Kincardine, Forfar, Perth, Fife (*Roy & Biss.*).

Ireland.—Mayo! Dublin and Wicklow (*Arch.*). Lough Derryadd, Armagh!

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Servia. Norway. Sweden. Denmark. Finland. N. Russia. Nova Zembla. Spitzbergen. Greenland. United States and Alaska. Patagonia. Antarctic.

Good figures of *St. Brebissonii* have always been wanting, and it is evident that different workers have had different conceptions of the species. The figure given (Pl. CXXXVII, fig. 4) is copied from a drawing by the late Dr. Lütkemüller.

The chief characters seem to be the depressed semicells, separated by a fairly open sinus, and the spines considerably longer at the angles. Lütkemüller's end view differs considerably from that of de Brébisson in its very much more concave lateral margins and more acute angles.

Lundell criticises Cleve's figure of the zygospore of this species (described by Cleve under the name of *St. pilosum*), since he found that instead of having appendages first trifurcate and then bifid as figured by Cleve, the zygospores have spines which are 3 or 4 times dichotomous at the apex. Lundell also states that the lower undivided part of the process is a little shorter than figured by Cleve.

Var. **brevispinum** West. (Pl. CXXXVII, fig. 6.)

St. Brebissonii var. *brevispinum* West, Alg. Engl. Lake Distr. 1892, p. 19, t. 9, f. 26.

Differs from the type in its relatively shorter and stouter spines, and also in the relatively greater length of the cells.

Length 49 μ; breadth, not including the spines, 42·5 μ; with spines, 45 μ; breadth of isthmus 17·5 μ.

ENGLAND.—Brother's Water, Westmoreland!

Geogr. Distribution.—United States.

87. **Staurastrum pilosum** (Näg.) Arch. (Pl. CXXXVIII, figs. 1–3.)

Phycastrum (*Amblyactinium*) *pilosum* Näg. Gatt. einz. Alg. 1849, p. 126, t. 8, A, f. 4,

Staurastrum pilosum Arch. in Pritch. Inf. 1861, p. 739; Rabenh. Flor. Europ. Alg. 1868, p. 212; Wittr. Skandinav. Desm. 1869, p. 17, t. 1, f. 8; Nordst. Desm. Arctoæ, 1875, p. 34; Gay, Monogr. loc. Conj. 1884, p. 68; Cooke, Brit. Desm. 1887, p. 150, t. 52, f. 5; De Toni, Syll. Alg. 1889, p. 1166; Anderss. Sverig. Chlor. 1890, p. 12; West, Alg. W. Ireland, 1892, p. 175; Alg. aq. dulc. Lusitan. 1892, p. 1503; Roy & Biss. Scott. Desm. 1893, p. 23; West & G. S. West, Alg. S. England, 1897, p. 494; Börg. Freshw. Alg. Faeroes, 1901, p. 230; West & G. S. West, Alg. N. Ireland, 1902, p. 48; Alga-fl. Yorks. 1902, p. 99.

St. saxonicum f. *tenue* Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 19, t. 2, f. 14.

Cells small, about as long as broad, deeply constricted, sinus acute, opening widely; semicells subelliptical or subfusiform, angles somewhat acutely rounded. cell-wall covered with delicate spines arranged in concentric

series round the angles. Vertical view triangular, sides strongly concave, angles acutely rounded.

Zygospore, according to Wittrock, spherical, provided with a number of stout processes, trifid or bifid for about half their length, and each part bifid again at its apex.*

Length, without spines, 42·5–44 μ ; breadth 38–47 μ ; breadth of isthmus 11 μ ; length of spines about 2 μ ; diam. zygosp., without spines, 56–57 μ ; with spines, 88 μ.

ENGLAND.—Cumberland ! Westmoreland ! Lancashire ! W. and N. Yorks ! Essex ! Oxford ! Plankton of Bracebridge Pool, Warwicks ! Surrey ! Kent ! Hants ! Devon ! Cornwall !

WALES.—Fairly general !

SCOTLAND.—General, but scarce ; zygospores from Cammie, Kincardine and Glen Coe, Argyle (*Roy & Biss.*). Newton Stewart, Wigtown ! Near Lochmaddy, N. Uist, and N. of Stornoway, Lewis, Outer Hebrides. Plankton of the Orkneys and Shetlands.

IRELAND.—Donegal ! Mayo and Clare Island ! Galway ! Kerry ! Dublin and Wicklow (*Arch.*). Down (at 2000 feet on Slieve Donard) ! Londonderry !

Geogr. Distribution.—Germany. Galicia and Austria. Hungary. Norway. Sweden. Bornholm. Portugal. Finland. N. Russia. Faeroes. Iceland. Spitzbergen. Greenland. Siberia. Central Africa (var.).

It is in the case of a species such as *St. pilosum* that the loss of Professor West's critical remarks is to be most deplored. Unfortunately information concerning this species is entirely wanting in all his publications. The fact that certain correspondence passed between him and the Austrian algologist, Dr. Lütkemüller, shows that he was in some doubt about the species. Dr. Lütkemüller had examined all the exsiccatæ of supposed *St. pilosum* that he possibly could, and it is clear from a perusal of the cor-

* The writer is of the opinion that it is very doubtful whether the Desmid figured by Wittr. ('Skand. Desm.' 1869, t. 1, f. 8), really was *St. pilosum*, since it agrees more nearly with *St. hirsutum* in the form of its semicells. In that case the figure of the zygospore given by Wittrock and reproduced on Pl. CXXXVIII, f. 2, may not be correct for *St. pilosum*. This zygospore is, indeed, very similar to Lütkemüller's figure of the zygospore of *St. hirsutum* (*cf.* Pl. CXXXVIII, f. 6).

respondence between the two algologists that Dr. Lütkemüller considered all the specimens of so-called *St. pilosum* he had examined to be without exception either *St. hirsutum* or *St. muricatum*. Thus Dr. Lütkemüller came to the conclusion that no one knows what *St. pilosum* Näg. really is, and he was accordingly very doubtful about its being a valid species. Whether Professor West agreed with Dr. Lütkemüller on this point is not certain. A particular alga first identified amongst his records as *St. pilosum* was later altered to *St. Brebissonii*, but the date at which the alteration took place is not known. The specimens in question have been examined and they are very similar to Pl. CXXXVIII, fig. 3. The actual specimen there figured was taken from a collection from Esher West End Common, and identified by Professor West as *St. pilosum* Näg. Professor West left only one drawing of *St. pilosum*, and a rough freehand drawing of the vertical view. These are reproduced on Pl. CXXXVIII, fig. 1. From these and from certain other rough sketches it would seem that Professor West's original idea of *St. pilosum* was that it should be similar in size to *St. hirsutum* Bréb., but that its semicells should be narrowly elliptical rather than truncate-pyramidate as in that species, and its spines should be somewhat longer and more delicate. In vertical view the lateral margins are distinctly concave. Lütkemüller was of the opinion that Nägeli's original figure of *St. pilosum* merely represents a smooth *Staurastrum* in which the pore threads had hardened and were distinctly visible.

88. **Staurastrum hirsutum** (Ehr.) Bréb.

(Pl. CXXXVIII, figs. 4–6.)

Xanthidium hirsutum Ehr. Org. kl. Raum. 1834, p. 318; Menegh. Syn. Desm. 1840, p. 223; Kütz. Spec. Alg. 1849, p. 177.
Euastrum hirsutum Kütz. Phyc. Germ. 1845, p. 137.
Staurastrum muricatum Ralfs in Ann. Mag. Nat. Hist. 1845 (in part), t. 11, f. 1, *a*, *b*, and *c*.
St. hirsutum (Ehr.) Bréb. in Ralfs, Brit. Desm. 1848, p. 127, t. 22, f. 3; Rabenh. Krypt.-fl. Sachs. 1863, p. 190; De Not. Desm. Ital. 1867, p. 50, t. 4, f. 41; Rabenh. Flor. Europ. Alg. 1868, p. 211; Kirchn. Alg. Schles. 1878, p. 166; Wolle, Desm. U. S. 1884, p. 141, t. 45, f. 19–21 (accuracy very doubtful); Cooke, Brit. Desm. 1887, p. 149, t. 52, f. 1; Hansg. Prodr. Algenfl. Böhmens, 1888, p. 214; De Toni, Syll. Alg. 1889, p. 1165; Heimerl, Desm. alp. 1891, p. 605; West, Alg. W. Ireland, 1892, p. 174; Alg. Engl. Lake Distr. 1892, p. 19; Racib. Desm. Ciast. 1892, p. 389; Roy & Biss. Scott. Desm. 1893, p. 21; West & G. S. West, Alg. S. England, 1897, p. 494; Alga-fl. Yorks. 1902, p. 100; Alg. N. Ireland, 1902, p. 48.
Phycastrum apiculosum Kütz. Spec. Alg. 1849, p. 182.

Staurastrum silesiacum Hilse in Rab. Alg. Eur. no. 1826.
St. muricatum Nordst. Desm. Bornh. 1888, p. 203, t. 6, f. 19–22.
St. pilosum f. *minor* Wittr. & Nordst. Alg. exsic. nos. 1474 & 469 (f. *minor* sec. Dr. J. Lütkemüller).

Cells small, up to $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus narrow, nearly linear for some distance, then opening more widely; semicells subpyramidate-truncate, subreniform or even subsemicircular, usually widest near the base, angles broadly rounded; cell-wall covered with delicate hair-like spines arranged in concentric series round the angles. Vertical view triangular, sides nearly straight, rarely very slightly convex or concave, angles obtusely rounded, centre of apex smooth. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore roughly spherical, but somewhat angular, provided with numerous stout processes repeatedly forked at the apex.

Length, without spines, 34–44 μ; breadth, without spines, 31–35 μ; breadth of isthmus 10–13 μ; length of spines 1·5–2 μ; diam. zygosp., without processes, 38 μ; with processes, 69 μ.

ENGLAND. — Cumberland! Westmoreland! Lancashire! (*Ralfs*). W. and N. Yorks! Leicester (*Roy*). Essex! Warwicks (*Wills*). Worcester! Surrey! Sussex (*Ralfs*). Kent! Hants! (*Bennett*). Devon! (*Harris*). Cornwall!

WALES.—General!

SCOTLAND.—General! (*Roy. & Biss.*). Orkneys! Shetlands! Rare in the plankton!

IRELAND.—Donegal! Mayo! Galway! Kerry! Shores of Lough Neagh! Dublin and Wicklow (*Arch.*). Down!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Roumania. Italy. Portugal. Norway. Finmark. Sweden. Denmark. Bornholm. Faeroes. Spitzbergen. Greenland. United States. Colombia. Brazil. Paraguay.

St. hirsutum is distinguished from all allied species by the form of its semicells, which are always wider at the base than else-

where, the basal margin being almost straight, and the sinus in consequence quite narrow. Some forms with shorter spines are very similar to *St. muricatum* Bréb., and it is often difficult to draw a sharp line between the two species. *St. muricatum* is usually larger than *St. hirsutum*, and its spines are much shorter.

89. **Staurastrum muricatum** Bréb.

(Pl. CXXXVIII, fig. 9; Pl. CXXXIX, figs. 1, 2.)

Binatella muricatum Bréb. Alg. Falaise, 1835, p. 269.
Staurastrum muricatum Bréb. in Menegh. Synops. Desm. 1840, p. 226 (in part); Ralfs, Brit. Desm. 1848, p. 126, t. 22, f. 2; Arch. in Pritch. Inf. 1861, p. 740; Rabenh. Krypt.-fl. Sachs. 1863. p. 190; De Not. Desm. Ital. 1867, p. 56, t. 4, f. 42; Rabenh. Flor. Europ. Alg. 1868, p. 208; Nordst. Norges Desm. 1872, p. 29; Delponte, Spec. Desm. subalp. 1877, p. 151, t. 11, f. 51, 52; Kirchn. Alg. Schles. 1878, p. 164; Wolle, Desm. U.S. 1884, p. 127, t. 42, f. 3, 4; Cooke, Brit. Desm. 1887, p. 159, t. 54, f. 5; De Toni, Syll. Alg. 1889, p. 1189; Heimerl, Desm. Alp. 1891, p. 605; Lütkem. Desm. Attersees, 1893, p. 566; Roy & Biss. Scott. Desm. 1893, p. 22; West & G. S. West, Alg. S. England, 1897, p. 494; Comère, Desm. de France, 1901, p. 175, t. 12, f. 7; West & G. S. West, Alga-fl. Yorks. 1902, p. 102; Alg. N. Ireland, 1902, p. 50; Gutw. Alg. Mont. Tatrensium, 1909, p. 472; Borge, Botan. Notis. 1913, p. 29.
Xanthidium deltoideum Corda, Alm. de Carlsbad, 1840, p. 214, t. 5, f. 38, 39.
Goniocystis (Trigonocystis) muricata β rugosa Hass. 1845, p. 19, t. 84, f. 10.
Staurastrum muricata β Ralfs in Ann. Mag. Nat. Hist. 1845, p. 154, t. 11, f. 1, *d* and *e*.
Phycastrum muricatum Kütz. Spec. Alg. 1849, p. 182.
Phycastrum (Amblyactinium) muricatum Näg. Gatt. einz. Alg. 1849, p. 125.

Cells of medium size, about $1\frac{1}{6}$ times longer than broad, rarely $1\frac{1}{3}$ times longer, deeply constricted, sinus narrow, but opening more widely; semicells subelliptical or reniform, sometimes truncate-pyramidate, dorsal margin much more convex than the ventral, angles obtusely rounded. Cell-wall covered with minute conical granules arranged in close concentric series round the angles. Vertical view triangular, sides straight or very slightly convex, angles obtusely rounded, granules in the centre of the apex often reduced or wanting. Chloroplast axile, with a single pyrenoid in the centre of each semicell, and a pair of lobes extending into each angle.

Zygospore unknown.

Length 46–62·5 μ: breadth 40–55 μ; breadth of isthmus 12–21 μ.

ENGLAND.—Cumberland! Westmoreland! W. and N. Yorks! Essex! Warwicks! (*Wills*). Surrey! Sussex (*Ralfs*). Hants! Devon! (*Harris*). Cornwall! (*Marquand*).

WALES.—Fairly general!

SCOTLAND.—Sutherland, Ross, Inverness, Aberdeen (at 3500 feet on Lochnagar!), Kincardine, Forfar, Perth! Argyle, Arran (*Roy & Biss.*). Dumbarton (*Carter*). Kircudbright! Orkneys! Shetlands!

IRELAND.—Donegal! Clare Island and Inishturk Isle, Mayo! Galway! Kerry! Down!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Norway. Sweden. Denmark. Bornholm. Finland. Faeroes. Australia (var.). United States and Alaska.

St. muricatum is very widely distributed in the British Isles. It is closely allied to *St. hirsutum*, from which it is distinguished by its usually larger size and much shorter spines, which are, as a rule, reduced to small conical granules. Intermediate forms between the two species are, however, not unknown.

90. **Staurastrum pyramidatum** West.

(Pl. CXXXVIII, figs. 10–12; Pl. CXXXIX, fig. 16.)

Staurastrum muricatum forma West, Alg. N. Yorks. 1889, p. 293.
St. muricatum var. *acutum* West, Alg. N. Wales, 1890, p. 294, t. 5, f. 14 Hirn. Desm. Finnland, 1903, p. 22.
St. pyramidatum West, Alg. W. Ireland, 1892, p. 179; Alg. Engl. Lake Distr 1892, p. 20; Alg. aq. dulc. Lusitan. 1892, p. 1503; West & G. S. West, Alg S. England, 1897, p. 494; Gutwin. Karlsbad Algen, 1899, p. 6; West & G. S. West, Alga-fl. Yorks. 1902, p. 103; Alg. N. Ireland, 1902, p. 51.

Cells of medium size, $1\frac{1}{6}$–$1\frac{1}{3}$ times longer than broad deeply constricted, sinus usually almost linear, rarely slightly open; semicells broadly pyramidate, apex subtruncate, sides slightly convex, basal angles obtusely rounded; cell-wall covered with stout acute conica spines, arranged in concentric series round the angles becoming more scattered and sometimes emarginate or

the apex, the centre of which is usually smooth. Vertical view triangular, sides straight, angles obtusely rounded. Chloroplast axile, with a central pyrenoid in each semicell, and a pair of plates extending into each angle.

Zygospore large and spherical, provided with numerous short stout processes, repeatedly branched at the apex.

Length 60–84 μ; breadth 52–57 μ; breadth of isthmus 16–18 μ; diam. zygosp., without appendages, 57 μ; with appendages, 80 μ.

England.—Scawfell, Cumberland (with zygospores)! Bowness and Helvellyn, Westmoreland! Cocket Moss, near Giggleswick, Cautley Spout and Penyghent, W. Yorks! Mickle and Cronkley Fells, N. Yorks! Keston Common, Kent! Dartmoor, Devon! Near St. Just, Cornwall!

Wales.—Snowdon, Llyn Idwal and Yr Orsedd, Carnarvonshire!

Scotland.—Scourie, Sutherland! Glen Tilt, Perth! Wigtown!

Ireland.—Carrantuohill, Co. Kerry! Slieve Donard, Down (at 2000 feet)!

Geogr. Distribution.—Germany. Portugal. Finland. E. Africa.

St. pyramidatum is distinguished from *St. muricatum* by the more definitely truncate-pyramidate form of its semicells, and by its more robust conical spines. It is a common species in upland boggy districts. *St. trapezicum* Boldt, var. *campylospinosum* Schmidle (in 'Hedwigia,' 1895, p. 81, t. 1, f. 25), is probably a form of this species.

Var. **coilon** West. (Pl. CXXXVIII, fig. 13.)

St. pyramidatum var. *coilon* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 11, t. 2, f. 46.

This variety differs from the type in its more numerous granules; in the vertical view the lateral margins are furthermore concave, and the angles subacute.

Length, without spines, 72·5 μ; with spines, 80 μ;

breadth, without spines, 60 μ: with spines, 65 μ; breadth of isthmus 17·5 μ.

SCOTLAND.—Corrie Ceandor, Perth!

91. **Staurastrum Ravenelii** Wood.

(Pl. CXXXVIII. figs. 7, 8.)

St. Ravenelii Wood, Freshw. Alg. N. Amer. 1873, p. 153, t. 21, f. 22; Wolle, Desm. U. S. 1884, p. 143, t. 45, f. 17, 18, t. 52, f. 7, 8; De Toni, Syll. Alg. 1889, p. 1172; West & G. S. West, Some Desm. U. S., 1898, p. 312.
St. Trelleckense Turn. Desm. Notes, 1893, p. 345, f. 12; Nordst. in Wittr. & Nordst. Alg. exsic. no. 1477, and fasc. 35, 1903, p. 11.

Cells small, about as long as broad or a little longer, deeply constricted, sinus linear for some distance, then opening more widely; semicells subelliptical or subreniform, or even subpyramidate-truncate, dorsal margin much more convex than the ventral, basal angles broadly rounded. Cell-wall provided with conical granules, arranged in rather distinct concentric circles round the angles, and sometimes becoming emarginate, about 8 or 9 rows visible across the face of the semicell. Vertical view triangular, lateral margins nearly straight, granules wanting in the centre of the apex.

Zygospore unknown.

Length 28–36 μ: breadth 28–32 μ; breadth of isthmus 8–14 μ.

WALES.—Trelleck Common, Monmouth (*W. B. Turn.*).

Geogr. Distribution.—Sweden. United States.

It is suggested amongst the notes of the late Professor West that *St. Trelleckense* Turn. is synonymous with *St. Ravenelii* Wood. Although the figures of Wolle, Wood, and Turner are all poor, certain similarities are evident, for they seem to represent a small *Staurastrum* with oval or elliptical semicells, lateral angles broadly rounded, and with the cell-wall covered with acute conical granules. (The error in Wolle, 'Desm. U. S.' 1884, t. 45, f. 18, is pointed out by the author himself.) The alga distributed in Wittr. & Nordst. 'Alg. Exs.' no. 1477, as a form of *St. Trelleckense* Turn. seems to differ in several points from the plant figured by the above authors, *cf.* Pl. CXXXVIII, figs. 7, 8. The semicells are more depressed, and instead of being more

or less oval they are subhexagono-trapezoid. The sinus is also somewhat narrower. The real characters of *St. Ravenelii* and *St. Trelleckense* are, however, still imperfectly known.

92. **Staurastrum erasum** Bréb.

(Pl. CXXXVII, figs. 9–11.)

St. erasum Bréb. Liste Desm. 1856, p. 143, t. 1, f. 28; Rabenh. Flor. Europ. Alg. 1868, p. 212; De Toni, Syll. Alg. 1889, p. 1147; Roy & Biss. Scott. Desm. 1893, p. 19; West & G. S. West, Notes Alg. II, 1900, p. 296; Comère, Desm. de France, 1901, p. 164, t. 12, f. 4; Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 43, t. 2, f. 13; West & G. S. West, Further Contr. Freshw. Plankt. Scott. Lochs, 1905, p. 487; Brit. Freshw. Phytoplankt. 1909, p. 202; Grönblad, Desm. Keuru, 1920, p. 62, t. 3, f. 92–94.

St. Brebissonii var. *ordinatum* Schmidle, Lappmark Süsswasseralgen, 1898, p. 53, t. 3, f. 1.

Cells small, about as long as broad, deeply constricted, sinus acute, widening rapidly outwards; semicells subelliptical, ventral margin much more convex than the dorsal, which is subtruncate; angles broadly rounded, and slightly retuse; cell-wall thickly covered with short spines arranged in concentric circles round the angles, where they are longest, and becoming very much reduced towards the centre of the faces. Vertical view triangular, sides concave, centre of apex nearly or quite smooth.

Zygospore unknown.

Length, without spines, 30–42 μ; breadth, without spines, 30–42 μ; breadth of isthmus 10–11 μ; length of spines at the angles, about 1·5 μ.

England.—Plankton of Hayes Water, Westmoreland! Risley Bog, Lancashire (*Roy*).

Wales.—Glyder Fach (at 2200 feet), Carnarvonshire! In the plankton!

Scotland.—Near Coul, Ross (*Roy & Biss.*). Loch Ruar, Sutherland! L. Ghorma, Inverness! Lochnagar, Aberdeen (up to 3500 feet)! L. Doon, Ayr! Plankton of Lochs Brindister and Beosetter, Bressay, Shetlands!

Geogr. Distribution.—France. Germany. Sweden (form). Finland. Siberia. United States (var.).

St. crasum is distinguished from *St. Brebissonii* by its more numerous and usually shorter spines, and it also differs in the shape of its semicells, the apex being almost flat, and the semicells widest in this region.

93. **Staurastrum erostellum** W. & G. S. West.
(Pl. CXXXVI, fig. 12.)

St. rostellum var. *erostellum* West & G. S. West, Alg. S. England, 1897, p. 493, t. 6, f. 18.
St. erostellum W. & G. S. West, Notes Alg. II, 1900, p. 296.

Cells small, about as long as broad, deeply constricted, sinus acute angled and widely open; semicells inverted subreniform, apex nearly straight or slightly convex; cell-wall covered with short stout spines arranged in concentric series around the angles, and rather longer at the angles than elsewhere. Vertical view triangular, lateral margins slightly concave, angles somewhat rounded.

Zygospore unknown.

Length, without spines, 19·5 μ; breadth, without spines, 19·5 μ; breadth of isthmus 6·5 μ.

England.—Thursley Common, Surrey!

St. erostellum differs from *St. cosmospinosum* (Börg.) W. & G. S. West (=*St. rostellum* Roy & Biss.) in its smaller size, its deeper constriction and different form of the semicells, in the absence of the large spine at the angles of the semicells, and also in the triangular vertical view with more rounded angles.

The relative size, number, and arrangement of the smaller spines is the same as in *St. cosmospinosum*, although in the latter species they do not increase in size towards the angles.

Fritch ('Freshw. Alg. Madagascar,' 1914, p. 51) has suggested that this species may be a form of *St. claviferum* W. & G. S. West ('North American Desm.' 1895, p. 259, t. 16, f. 25). In this species, however, the shape of the cell is quite different.

SECTION G.

Cells with verrucæ which are emarginate, or very much reduced and 2- or 3-spinate.

* Cells more than $1\frac{1}{3}$ times longer than broad.

† Lateral margins with an incision or rounded concavity; semicells angular.

94. *St. acarides.*

†† Lateral margins entire; semicells subelliptic.

95. *St. asperum.*

** Cells about as long as broad or only slightly longer.

† Verrucæ restricted to the angles and apex; faces of semicell smooth.

96. *St. maamense.*

†† Verrucæ more or less evenly distributed.

‡ Verrucæ surmounting distinct though short processes pushed out from the cell-wall.

97. *St. spongiosum.*

‡‡ Verrucæ borne directly on the cell-wall.

98. *St. echinodermum.*
99. *St. Arnellii.*
100. *St. scabrum.*
101. *St. subscabrum.*

94. **Staursatrum acarides** Nordst.

(Pl. CXL, figs. 6, 7.)

St. acarides Nordst. Desm. Spetsb. 1872, p. 40, t. 7, f. 26; Joshua, Notes on Brit. Desm. II, 1883, p. 292; Cooke, Brit. Desm. 1887, p. 153, t. 60, f. 5; De Toni, Syll. Alg. 1889, p. 1169; West, Alg. N. Yorks. 1889, p. 293; Roy & Biss. Scott. Desm. 1893, p. 16; Borge, Süsswasseralgen Franz Josefs-Land, 1899, p. 764.

Cells rather under medium size, about $1\frac{1}{3}$ times longer than broad, oblong elliptic in outline; constriction moderately deep, sinus linear, dilated at its apex, semicells pyramidate-truncate, somewhat angular, apex broad and truncate, or often slightly concave, basal angles almost rectangular, upper angles obtusely rounded, lateral margins verrucose, with a small rounded concavity just above the middle part; semicells in front view with several short longitudinal series of verrucæ, rather more crowded towards the angles. Vertical view triangular, sometimes hexangular, lateral margins verrucose and slightly convex, angles bluntly rounded, with

2 or 3 concentric series of verrucæ around the middle of the apex, the actual centre being smooth.

Zygospore unknown.

Length 40–48 μ; breadth 30–34 μ; breadth of apex 17·5–20 μ.

England.—Penyghent and Mickle Fell, N. Yorks!

Scotland.—Craig Phiobaidh near Girnoc and Corrie of Loch Ceannmhor, Aberdeen; Canlochan, Forfar: Alva Glen, Stirling (*Roy & Biss.*).

Geogr. Distribution.—Norway. Sweden. Faeroes. Nova Zembla. Spitzbergen. W. Greenland.

The British examples differ from the original specimens from Spitzbergen in their proportionate greater length and in the convex sides in the vertical view. They also seem to be more strongly verrucose.

Var. **eboracensis** West. (Pl. CXL, figs. 8–10.)

St. acarides var. *eboracensis* West, Alg. N. Yorks. 1889, p. 273, t. 291, f. 8; West & G. S. West, Alga-fl. Yorks. 1902, p. 106.

Differs from the type in its deeper lateral incisions, which are almost linear.

Dimensions as in the type.

England.—Mickle Fell, N. Yorks!

95. **Staurastrum asperum** Bréb.

(Pl. CXL, figs. 11–13; Pl. CXLI, fig. 21.)

Staurastrum asperum Bréb. in Ralfs, Brit. Desm. 1848, p. 139, t. 22, f. 6, t. 23, f. 12*a*: Arch. in Pritch. Inf. 1861, p. 740: Rabenh. Flor. Europ. Alg. 1868, p. 209; Cooke, Brit. Desm. 1887, p. 154, t. 53, f. 4: De Toni, Syll. Alg. 1889, p. 1175; Roy & Biss. Scott. Desm. 1893, p. 179; West & G. S. West, New Brit. Freshw. Alg. 1894, p. 11, t. 2, f. 48; Comère, Desm. de France, 1901, p. 169, t. 12, f. 27.
Didymidium (Staurastrum) asperum Reinsch, Algenfl. Frank. 1867, p. 160.

Cells rather under medium size, about $1\frac{1}{3}$ times longer than broad, deeply constricted, sinus open and nearly rectangular; semicells broadly elliptical, widest towards the apex, dorsal margin much less convex than the ventral, angles broadly rounded: peripheral margin

with about 18–20 granules, the apical ones more or less flattened or emarginate, granules in front view of semi-cell arranged in about 7 longitudinal rows, the median row incomplete, and the uppermost granule of each row larger and emarginate. Vertical view 3–5-angular, sides straight and granulate, angles broadly rounded and bearing a few spines longer than the rest, with a curved series of about 6 emarginate granules within each lateral margin; centre of apex smooth.

Zygospore orbicular, spines twice branched at the apex.

Length 42–52 μ; breadth 34–47 μ; breadth of isthmus 12–15 μ; diam. zygosp., without processes, 47·5 μ; with processes, 75 μ.

England. — Westmoreland! (*Bissett*). N. and E. Yorks! Lancashire! Leicester (*Roy*). Warwicks (*Wills*). Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Hants! Devon (*Harris*)! Cornwall!

Wales.—Capel Curig and Llyn Idwal, Carnarvonshire! Ffestiniog, Merioneth!

Scotland.—Sutherland, Ross, Aberdeen, Kincardine, Forfar, Perth and Fife (*Roy & Biss.*). Loch Shiel, Inverness! Orkneys! In the plankton!

Ireland.—Clare Island, Mayo! Near Oughterard and Ballynahinch, Co. Galway! Carrantuohill, Co. Kerry! Dublin and Wicklow (*Arch.*). Munster, Leinster and Connaught (*Adams*).

Geogr. Distribution.—France. Germany. Galicia and Austria. Sicily. Sweden. Faeroes. United States.

96. **Staurastrum maamense** Arch.

(Pl. CXXXIX, fig. 10.)

St. maamense Arch. in Quart. Journ. Micr. Sci. vol. 9, 1869, p. 200; Cooke, Brit. Desm. 1887, p. 155, t. 53, f. 3; De Toni, Syll. Alg. 1889, p. 1175; West, Alg. W. Ireland, 1892, p. 176; Roy & Biss. Scott. Desm. 1893, p. 184; West & G. S. West, Some N. Amer. Desm. 1896, p. 260; Brit. Freshw. Phytoplankton, 1909, p. 202.

St. pseudocrenatum Lund. Desm. Suec. 1871, p. 65, t. 4, f. 4; Wolle, Freshw. Alg. U. S. 1887, p. 42, t. 57, f. 9, 10.

Cells small, as long as broad, or sometimes a little longer than broad, broadly oval or circular in outline, deeply constricted, sinus very narrow and linear; semicells nearly semicircular or subpyramidate-truncate, ventral margin straight, dorsal margin somewhat flattened on the apex, lateral margins with about 4 emarginate verrucæ, which are seen when the angle is viewed from the front as a series of broad complicated verrucæ extending from the apex to the base of the semicell; upper margin of faces with an apical series of verrucæ. Vertical view triangular, lateral margins concave, angles broadly truncate and tricrenate, with two or three series of verrucæ just within the truncate angles, and another series just within the concave margins.

Zygospore unknown.

Length 33–42 μ; breadth 30–35 μ; breadth of isthmus 10 μ.

England.—Near Bowness, Westmoreland (*Bissett*).

Scotland.—Powlair, Rosehill Loch, Craigendinnie, Moss of Logie, Loch Dawan, Aberdeen; Craithes, Kincardine; near Tobermory in Mull, Argyle (*Roy & Biss.*). Moidart, Inverness!

Ireland.—Ballynahinch!, Derryclare Lough!, plankton of Lough Corrib! and near Maam (*Archer*), Galway. Adrigole, Co. Cork!

Geogr. Distribution.—Norway. Sweden. Finland. United States.

97. **Staurastrum spongiosum** Bréb.
(Pl. CXL, fig. 14.)

Binatella spongiosa Bréb. in Cheval. microscop. et usage, 1839, p. 272.
Staurastrum spongiosum Bréb. in Ralfs, Brit. Desm. 1848, p. 141, t. 23, f. 4; Arch. in Pritch. Inf. 1861, p. 739, t. 3, f. 22, 23; Rabenh. Krypt.-fl. Sachs. 1863, p. 193; De Not. Desm. Ital. 1867, p. 48; Rabenh. Flor. Eur. Alg. 1868, p. 217; Lund. Desm. Suec. 1871, p. 65; Nordst. Norges Desm. 1873, p. 32; Kirchn. Alg. Schles. 1878, p. 166; Turn. New Rare Desm. 1885, p. 6, t. 15, f. 22; Cooke, Brit. Desm. 1887, p. 153, t. 53, f. 1; Boldt, Desm. Grönland, 1888, p. 39; West, Desm. Massach. 1889, p. 6, f. 21: De Toni, Syll. Alg. 1889, p. 1174; Racib. Desm. Ciaston. 1892, p. 389; West, Alg. W. Ireland, 1892, p. 175; Roy & Biss. Scott. Desm. 1893, p. 26; West & G. S. West, Alg. S. England, 1897, p. 494; Schmidle,

Lappmark Süsswasseralgen, 1898, p. 54; Comère, Desm. de France, 1901, p. 169, t. 12, f. 16; Hirn, Desm. Finnland, 1903, p. 23; Cushman in Rhodora, 1905, p. 204; Teodoresco, Alg. Roumania, 1907, p. 184; Borge, Botan. Notiser, 1913, p. 50; Kaiser, Alg. Traunstein, 1914, p. 158.
Asteroxanthium ramosum Kütz. Spec. Alg. 1849, p. 184.
Didymidium (Staurastrum) spongiosum Reinsch, Algenfl. Frank. 1867, p. 175.
Staurastrum megalonotum forma *hastata* Schmidle, Beitr. Alp. Alg. 1896, p. 35, t. 17, f. 6, 7.

Cells rather under medium size, about as long as broad, or a little longer, roughly circular in outline, deeply constricted, sinus narrow, sometimes almost linear; semicells subsemicircular or subpyramidate-truncate in outline, basal angles obtuse and ending in a short verrucose process; about 8 or 10 emarginate processes visible round the periphery, and 6 others forming a curved series across the face of the semicell. Vertical view triangular, sides usually slightly convex, angles ending in a short verrucose process, each lateral margin with 6 emarginate processes, and 3 similar pairs arranged across each angle, decreasing in size towards the angles; centre of apex smooth.

Zygospore spherical, furnished with numerous spines once or twice dichotomous at their apices (Lund.).

Length 45–53 μ; breadth 42–50 μ; breadth of isthmus 12 μ; diam. zygosp., without processes, 56 μ; length of processes 24 μ.

England.—Cumberland! Mickle Fell, N. Yorks! Warwicks (*Wills*). Surrey! Sussex (*Ralfs*). Hants (*Bennett*). Devon! Cornwall!

Wales.—Bethesda!, Dolbadarn Castle!, Llyn Padarn! and Capel Curig! (*Cooke & Wills*). Carnarvonshire. Dolgelly, Merioneth (*Ralfs*).

Scotland.—Sutherland, Ross, Inverness, Aberdeen, Kincardine, Forfar!, Perth!, Argyle and Stirling (*Roy & Biss.*).

Ireland.—Ballynahinch, Galway! Carrantuohill, Co. Kerry! Adrigole, Co. Cork! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Roumania. Italy. Portugal. Norway. Sweden. Finland. Poland. Central

Russia. Spitzbergen. Greenland. Siberia. United States. Argentine.

St. spongiosum is a beautiful species, and is very well characterised by its prominent and regularly arranged verrucæ, which are so large as almost to constitute short processes with emarginate apices. The front view naturally varies in appearance according as the individual is observed from the face view or the angle.

Var. **perbifidum** West. (Pl. CXL, fig. 16.)

St. spongiosum var. *perbifidum* West, Alg. W. Ireland, 1892, p. 175, t. 23, f. 3; Lütk. Desm. Attersees, 1893, p. 365, t. 9, f. 15; Schmidle, Beitr. Alp. Alg. 1896, p. 32; W. & G. S. West, Alg. S. England, 1897, p. 494; Börg. Alg. Faeroes, 1901, p. 234; Borge, Botan. Notiser, 1913, p. 50.

This variety differs from the type in that the granules of the emarginate processes are developed into stout spines.

Dimensions as in the type.

ENGLAND.—Borrowdale, Cumberland ! Thursley Common, Surrey (3- and 4-ended forms) !

IRELAND.—Near Westport, Co. Mayo !

Geogr. Distribution.—Germany. Austria. Sweden. Faeroes.

Transitional forms between this variety and the type form are frequent.

Var. **Griffithsianum** (Näg.) Lagerh. (Pl. CXL, fig. 15.)

Phycastrum (Pachyactinium) Griffithsianum Näg. Gatt. einz. Alg. 1849, p. 128, t. 8, C. f. 2.

Staurastrum Griffithsianum Arch. in Quart. Journ. Micr. Sci. 1866, p. 67; Cooke, Brit. Desm. 1887, p. 154, t. 53, f. 2; Georgev. Desm. Wlasina Sees, 1909, p. 203.

St. spongiosum var. *Griffithsianum* Lagerh. in Wittr. & Nordst. Alg. exs. no. 821, 1886; De Toni, Syll. Alg. 1889, p. 1174; Lütkem. Desm. Attersees, 1893, p. 564; Borge, Botan. Notiser, 1913, p. 50.

Cells with the sinus open towards the exterior, sides in the end view nearly straight or slightly concave, with a deep rounded and prominent concavity between the two median processes of each lateral margin; in other characters similar to the type. In the development of its spines this variety resembles var. *perbifidum* West.

Dimensions as in the typical form.

England.—Dartmoor, Devon (*Harris*).

Wales.—Capel Curig and Dolbadarn Castle, Carnarvonshire !

Geogr. Distribution.—Finland. Germany. Switzerland. Galicia and Austria. Servia. Sweden. Spitzbergen. Greenland. Sandwich Isles.

Bennett in 'Freshw. Alg. Engl. Lake Distr.' II, 1888, p. 6, t. 1, f. 15, 16, has described a var. *cumbricum* of this species, but his figures and diagnosis are insufficient. It is not impossible that Bennett's variety is identical with the var. *perbifidum* of West.

98. **Staurastrum echinodermum** W. & G. S. West.

(Pl. CXXXIX, figs. 8, 9.)

St. echinodermum West & G. S. West, Notes Alg. III, 1903, p. 11, t. 446, f. 13.

Cells small, slightly longer than broad, deeply constricted, sinus open and acute angled; semicells angular but roughly elliptical, angles subtruncate, dorsal margin strongly convex, angles and apex with a series of about 8, often emarginate, spines, faces of semicell with two transverse series of spines; vertical view 4- or 5-angular, sides very slightly concave, angles acutely rounded, margins armed with short spines, and with 2 emarginate spines within each lateral margin.

Zygospore unknown.

Length, without spines, 31·5 μ; breadth, without spines, 27 μ; with spines, 30·8 μ; breadth of isthmus 10·5 μ.

Wales.—Glyder Fawr (at 2700 feet), Carnarvonshire !

99. **Staurastrum Arnellii** Boldt.

(Pl. CXXXIX, figs. 11–14.)

Staurastrum Arnellii Boldt, Sibir. Chlorophyc. 1885, p. 112, t. 5, f. 21 De Toni, Syll. Alg. 1889, p. 1170; West & G. S. West, Notes Alg. II, 1900, p. 297, t. 412, f. 15–18; Alga-fl. Yorks. 1902, p. 103; Alg. N. Ireland, 1902, p. 51; Brit. Freshw. Phytopl. 1909, p. 203.

Cells small, $1\frac{1}{5}$ times longer than broad, deeply constricted, sinus narrow, sometimes linear; semicells pyramidate-truncate, ventral margin straight, apex truncate, sides slightly convex, upper angles very obtuse, basal angles broadly rounded, peripheral margin denticulate, showing about 26 or 28 granules, those near the basal angles sometimes developing into short spines; faces of semicell granulate near the margin, granules arranged in 2 or 3 concentric series round the basal angles, and in about 3 series parallel to the apical margin, the latter being emarginate; granules in the middle of the faces becoming smaller and scattered, centre of face almost smooth. Vertical view triangular, angles obtusely rounded, sides very slightly concave, margins denticulate, those granules in the middle of lateral margins being emarginate; angles with two or three concentric series of denticulations, and with two pairs of emarginate verrucæ within each lateral margin.

Zygospore unknown.

Length 30–38·5 μ; breadth 31–38·5 μ; breadth of isthmus 9·5–12 μ.

England.—Mossdale Moor, Widdale Fell, N. Yorks!

Wales.—Y Foel Fras, Carnarvonshire!

Ireland.—Near Gweedore, Co. Donegal!

Geogr. Distribution.—Siberia.

Var. **inornatum** Roy.

St. Arnellii var. *inornatum* Roy, Desm. Alford District, 1890, p. 208; Roy & Biss. Scott. Desm. 1893, p. 17.

Differs from the type in the granules being scattered.

Scotland.—Very rare, near Alford, Aberdeen (*Roy & Biss.*).

Var. **spiniferum** W. & G. S. West. (Pl. CXXXIX, fig. 15.)

St. Arnellii var. *spiniferum* West & G. S. West, Alg. N. Ireland, 1902, p. 51, t. 2, f. 38.

Cells not so angular as in the type, sinus a little more open, and distinctly swollen at the apex; a few of the spines longer than in the type, the remaining ones normal.

Length 32 μ; breadth 30·5 μ; breadth of isthmus 9·7 μ.

IRELAND. — Slieve Donard, Co. Down (abundant amongst *Sphagnum*)!

100. **Staurastrum scabrum** Bréb.

(Pl. CXL, figs. 1, 2.)

St. scabrum Bréb in Ralfs, Brit. Desm. 1848, p. 214, t. 35, f. 20; Arch. in Pritch. Infus. 1861, p. 740; Rabenh. Flor. Europ. Alg. 1868, p. 217; Lund. Desm. Suec. 1871, p. 65; Wolle, Desm. U. S. 1884, p. 130, t. 41, f. 29, 30; Boldt, Desm. Grönland, 1888, p. 39, t. 2, f. 50; De Toni, Syll. Alg. 1889, p. 1170; West, Alg. N. Wales, 1890, p. 18; Lütkem. Desm. Attersees, 1893, p. 564; Roy & Biss. Scott. Desm. 1893, p. 25; Börg. in Wittr. & Nordst. Alg. exs. no. 1114, 1893, p. 11; Schmidle, Beitr. Alp. Alg. 1896, p. 32; Comère, Desm. de France, 1901, p. 170, t. 13, f. 6; West & G. S. West, Alg. N. Ireland, 1902, p. 51, t. 2, f. 36; Brit. Freshw. Phytoplankton, 1909, p. 203.

Cells small, a little longer than broad, deeply constricted, sinus open and acute; semicells elliptic-fusiform or subtrapeziform, dorsal margin mor econvex than the ventral, peripheral margin granulate, lateral angles subtruncate with about 3 acute granules at each; cell-wall granulate, granules arranged in 8 longitudinal rows down the face of the semicell, those near the angles consisting of simple granules, but in the 4 median series the granules scattered in groups. Vertical view triangular, angles rounded, sides very slightly concave, margins denticulate, granules in the median part of the lateral margins often emarginate, and with about 2 series of emarginate granules just within the margin. Chloroplast axile, with a central pyrenoid in each semicell and a pair of lobes extending into each angle.

Zygospore globular, sometimes slightly oblong, with short stout spines 3- or 4-fid at the apex, about 10–13 visible round the margin (*Roy & Biss.*).

Length 35–36 μ; breadth 32–38 μ; breadth of isth-

mus 9–13·5 μ; diam. zygosp., without spines, 32–35 μ; length of spines 5–6 μ.

ENGLAND.—Lunds Fell, N. Yorks!

WALES.—Capel Curig, Moel Siabod, Llyn Bochlwyd and Llyn-y-cwm-ffynon, Carnarvonshire!

SCOTLAND.—Shetlands, Sutherland, Ross, Moray, Aberdeen, Kincardine, Forfar, Perth, Fife, Argyle, Arran; zygospores from Cambus O'May, Aberdeen (*Roy & Biss.*). Orkneys!

IRELAND.—Glendowan, near Glenties, and Loughs Anure, Clogher and Magrath, Donegal! Achill Isle, Mayo! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Austria. Norway. Sweden. Denmark. Finland. Faeroes. Greenland. Azores. United States.

101. **Staurastrum subscabrum** Nordst.

(Pl. CXL, figs. 3, 4.)

St. subscabrum Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 16, t. 2, f. 1; De Toni, Syll. Alg. 1889, p. 1177; West & G. S. West, Some N. Amer. Desm. 1896, p. 260, t. 18, f. 12; Comère, Desm. de France, 1901, p. 172, t. 12, f. 21; West & G. S. West, Alg. N. Ireland, 1902, p. 51, Brit. Freshw. Phytoplankton, 1909, p. 203.

Cells small, about as long as broad, nearly circular in outline, deeply constricted, sinus narrow, sometimes even linear; semicells subpyramidate-truncate, broad at the base, apex subtruncate, lateral margins slightly convex, about 6–8 granules visible along each, the upper ones emarginate; cell-wall provided with verrucæ arranged in decussating horizontal and longitudinal rows, the median ones emarginate; horizontal series 4 in number, vertical series about 6 or 8. Vertical view triangular, sides straight, each with about 4 or 6 emarginate verrucæ, and another similar series just within the margin, angles obtuse, with a few granules, centre of apex smooth. Chloroplast axile with a central pyrenoid in each semicell.

Zygospore unknown.

Length 27–32 μ ; breadth 26–32 μ ; breadth of isthmus 7·5–14 μ.

ENGLAND.—New Forest, Hants !

SCOTLAND.—Glen Dye, Kincardine (*Roy & Biss.*). Rhiconich, Sutherland !

IRELAND.—Lough Nacung, Donegal ! Kylemore, Galway !

Geogr. Distribution.—France. Sandwich Isles. United States.

St. subscabrum differs from *St. scabrum* in its proportionately shorter cells ; the sinus is narrower, and the semicells are more truncate-pyramidate in outline.

Forma **scabrior** West. (Pl. CXL, fig. 5.)

St. subscabrum forma *scabrior* West, Alg. W. Ireland, 1892, p. 176, t. 23, f. 4.

Differs from the type in its greater development of verrucæ, especially at the apices of the cell.

Length 40 μ ; breadth 35–37 μ ; breadth of isthmus 10 μ.

IRELAND.—Kylemore and Clifden, Co. Galway !

SECTION H.

Processes smooth, although usually emarginate, furcate or spinate at the extremity.

* Processes borne singly at the angles of the semicell.

† Processes always entire and distinctly capitate at the extremity.

102. *St. bacillare.*

†† Processes truncate, obtuse or furcate at the extremity, never capitate.

‡ Cells minute, semicells rectangular in form.

103. *St. franconicum.*
104. *St. inconspicuum.*
105. *St. nodosum.*

‡‡ Cells larger, semicells cuneate.

106. *St. brachiatum.*
107. *St. lævispinum.*
108. *St. sublævispinum.*

‡‡‡ Semicells globular.

109. *St. subnudibrachiatum.*

** Processes in pairs at the angles, all in the same horizontal plane.

110. *St. læve.*

102. Staurastrum bacillare Bréb.

(Pl. CXLI, figs. 9, 10.)

Binatella bacillaris Bréb. Alg. Falaise, 1835, p. 269.
Staurastrum bacillare Bréb. in Menegh. Synops. Desm. 1840, p. 228; Ralfs, Brit. Desm. 1848, p. 214, t. 35, f. 21; Bréb. Liste Desm. 1856, p. 145; Arch. in Pritch. Inf. 1861, p. 741; Rabenh. Flor. Europ. Alg. 1868, p. 201; Wolle, Freshw. Alg. U. S. 1887, p. 41, t. 57, f. 5, 6; De Toni, Syll. Alg. 1889, p. 1186; West, Alg. W. Ireland, 1892, p. 173; Comère, Desm. de France, 1901, p. 173, t. 12, f. 29; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 202.
Phycastrum bacillare Kütz. Spec. Alg. 1849, p. 181.
Didymidium (Staurastrum) bacillare Reinsch, Alg. Frank. 1867, p. 153.

Cells small, deeply constricted, sinus acute and nearly rectangular; semicells narrowly lunate, angles produced obliquely upwards into thick processes, ending with capitate apices. End view 3–5-angular, sides strongly concave, angles produced with capitate apices. Cell-wall smooth.

Zygospore unknown.

Length, without processes, about 16·2 μ; with processes, 33·8 μ; breadth, with processes, 30–37·5 μ; breadth of isthmus 7–8·7 μ.

IRELAND.—Lough Aunierin, Co. Galway! Munster and Connaught (*Adams*).

Geogr. Distribution.—France. Germany. Poland. Burma. United States. West Indies.

Var. obesum Lund. (Pl. CXLI, figs. 11, 12.)

St. bacillare var. *obesum* Lund. Desm. Suec. p. 57, t. 3, f. 24; De Toni, Syll. Alg. 1889, p. 1187; West, Alg. N. Wales, 1890, p. 16, t. 5, f. 4; Alg. W. Ireland, 1892, p. 173; Eichler, Mat. flor. Miedz. 1894, p. 133, t. 4, f. 55.

A variety with proportionately larger body of semicell; processes horizontal and very much reduced, almost entirely wanting, apex of cell slightly convex.

Length 17·5–23 μ; breadth 21–27 μ; breadth of isthmus 6–7·5 μ.

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Loch Dawan, Aberdeen (*Roy & Biss.*).

IRELAND.—Adrigole, Co. Cork!

Geogr. Distribution.—Sweden. Finland. United States.

Var. **undulatum** *var. nov.* (Pl. CXLI, fig. 13.)

St. bacillare var. *undulatum* W. & G. S. West in manuscript.

Cells rather larger and relatively longer than in the type, processes long and slender, more divergent, and with their outlines gently undulate. Vertical view triangular with very concave sides.

Length, without processes, 18 μ; with processes, 44 μ; breadth 37 μ; breadth of isthmus 8·5 μ.

SCOTLAND.—Rhiconich, Sutherland!

St. bacillare is a very rare Desmid, and only occurs in bogs on the older palæozoic rocks in the western parts of the British Isles. It is very variable in form, and scarcely any of the figures yet published agree exactly with the figures of Ralfs. Lagerheim ('La nuova Notarisia,' 1892, p. 29) would make definite varieties of the forms figured by both West ('Alg. N. Wales,' 1890, t. 5, f. 4) and Wolle ('Freshw. Alg. U.S.' 1887, t. 57, f. 5–6).

103. **Staurastrum franconicum** Reinsch.

(Pl. CXLII, figs. 9, 10.)

St. franconicum Reinsch in Rabenhorst, Alg. Eur. no. 1899, f. 1–3, 1866; Spec. Gen. Alg. 1867, p. 124, t. 4, B; Lund. Desm. Suec. 1871, p. 58; De Toni, Syll. Alg. 1889, p. 1213; Roy & Biss. Scott. Desm. 1893, p. 182.
Didymidium (*Staurastrum*) *franconicum* Reinsch, Algenfl. Frank. 1867, p. 158, t. 12, f. 3.

Cells small, about as long as broad, excluding the processes, or a little longer; body of cell nearly rectangular in form; sinus almost wanting, consisting of a minute excavation in the middle; semicells short and rectangular, apex and lateral margins concave or nearly straight, upper angles of semicell produced to form short

divergent processes, which are emarginate or tri-dentate at the apex; vertical view 2–5-radiate, lateral margins strongly concave, angles produced into processes. Cell-wall smooth, except for the processes, which are sometimes finely granulate.

Zygospore unknown.

Length (not including the processes) 14–17 μ; breadth (not including the processes) 11–15 μ; distance between the tips of the processes 19–30 μ.

SCOTLAND.—Bishop's Loch and Tomachar, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Germany. Italy. Scandinavia. United States.

Reinsch's figures include several *Staurastra* which differ amongst themselves in many respects, so that one almost doubts that they can all belong to the same species. Unfortunately, no other figures of *St. franconicum* have ever been published, and these original ones of Reinsch are very unsatisfactory.

104. Staurastrum inconspicuum Nordst.

(Pl. CXLI, figs. 4–7; Pl. CXLII, fig. 8.)

Staurastrum sp. Arch. in Quart. Journ. Micr. Sci. 1855, p. 89.
St. minutissimum Auersw. in Rab. Alg. Eur. 1863, no. 1428 (ex parte).
St. inconspicuum Nordst. Norges Desm. 1873, p. 26, t. 1, f. 11; Arch. in Journ. Bot. 1874, p. 91; Wolle, Desm. U. S. 1884, p. 125, t. 53, f. 4, 5; Cooke, Brit. Desm. 1887, p. 153, t. 54, f. 3; De Toni, Syll. Alg. 1889, p. 1183; Heimerl, Desm. alp. 1891, p. 606; West, Alg. W. Ireland, 1892, p. 178; Lütkem. Desm. Attersees, 1893, p. 565; Roy & Biss. Scott. Desm. 1893, p. 21; West & G. S. West, Some N. Amer. Desm. 1896, p. 257, t. 16, f. 14; Alg. S. England, 1897, p. 495; Lütkem. Desm. Millstättersees, 1900, p. 22, t. 1, f. 54; Comère, Desm. de France, 1901, p. 154, t. 11, f. 11; Börg. Alg. Faeroes, 1901, p. 235, t. 8, f. 4; West & G. S. West, Alg. N. Ireland, 1902, p. 49; Brit. Freshw. Phytoplankton, 1909, p. 203.
St. refractum Delp. Spec. Desm. subalp. 1877, p. 138, t. 11, f. 7–9.
St. subrefractum Lemaire, Liste Desm. Vosges, 1883, p. 23, t. 1, f. 3.

Cells minute, about as long as broad, including the processes, sinus nearly semicircular; semicells roughly quadrangular, apex slightly elevated but concave in the middle; upper angles produced to form short stout

processes, which are first directed obliquely outwards, and then, at a point halfway along their length, they are abruptly narrowed and directed obliquely upwards, ending with truncate apices. Vertical view 3–6-radiate, sides strongly concave, processes equal in length to about half the diameter of the "body" of the cell.

Zygospore oval or elliptical, smooth.

Length, without processes, 14–15·5 μ; with processes, 17–26 μ; breadth with processes = length with processes; breadth of isthmus 7–9 μ; length zygosp. 16 μ; breadth 11·3 μ.

ENGLAND.—Thursley Common and Devil's Jumps, Surrey! New Forest, Hants! Dartmoor and Woodbury Common, Devon (*Harris*)! Roughter Moor, Cornwall (*Marquand*)!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Sutherland!, Ross, Inverness, Moray, Aberdeen, Kincardine, Forfar, Perth! and Argyle (*Roy & Biss.*).

IRELAND.—Donegal! Mayo and Clare Isle! Galway! Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Belgium. Germany. Galicia and Austria. Norway. Sweden. Finland. Poland. N. Russia. Faeroes. Siam. Azores. United States. Colombia. Brazil.

Börgeson has observed examples of this species in which the cells were united to form short twisting filaments (see Pl. CXLII, f. 8).

Var. **crassum** Gay. (Pl. CXLI, fig. 8.)

St. inconspicuum var. *crassum* Gay, Mono. loc. Conj. 1884, p. 68, t. 2, f. 10; De Toni, Syll. Alg. 1889, p. 1183; West & G. S. West, New Brit. Alg. 1894, p. 11; Comère, Desm. de France, 1901, p. 154.

Processes stouter than in the type, distinctly jointed.

Length and breadth, including processes, 12–14 μ; breadth of isthmus 6·5–7 μ.

IRELAND.—Glen Caragh, Co. Kerry!

Geogr. Distribution.—France.

Dr. Lütkemüller ('Zellmembr. Desm.' 1902) states that the chloroplast in *St. inconspicuum* is very simple and possesses only one pyrenoid in the middle of the cell (instead of one in each semicell as is often the case in *Staurastrum*), so that the nucleus is lateral in position. This is a very unusual state of affairs for one of the higher Desmids. On the other hand, Gay (loc. cit.) figures for *St. inconspicuum* var. *crassum* pyrenoids in quite the normal position.

105. **Staurastrum nodosum** W. & G. S. West.

(Pl. CXLI, fig. 16.)

St. nodosum West & G. S. West, Alg. S. England, 1897, p. 495, t. 6, f. 23.

Cells very small, about as long as broad, including the processes, deeply constricted, sinus open with almost straight margins and very acute apex; semicells broadly oblong-rectangular, upper angles produced to form short truncate processes, strongly divergent, and with one abrupt constriction, lower angles nearly rectangular, apex of semicell concave: vertical view triangular, sides concave, processes truncate and biundulate; cell-wall smooth.

Zygospore unknown.

Length, without processes, 11 μ; with processes, 21 μ; breadth, with processes, 19 μ; breadth of isthmus 5 μ.

England.—Thursley Common, Surrey!

St. nodosum is similar in general appearance to *St. inconspicuum* Nordst., but is distinguished by its marked and deep constriction, and by the relatively smaller "body" in the end view.

106. **Staurastrum brachiatum** Ralfs.

(Pl. CXLI, figs. 14, 15; Pl. CXLII, figs. 1–7.)

Staurastrum bifidum Ralfs in Ann. Mag. Nat. Hist. 1845, p. 151, t. 10, f. 3.
Goniocystis (*Staurastrum*) *bifida* Hass. British Freshw. Alg. 1845, p. 355, t. 85, f. 2.
Staurastrum brachiatum Ralfs, Brit. Desm. 1845, p. 131, t. 23, f. 9; Arch. in Pritch. Inf. 1861, p. 741; Rabenh. Krypt. Flor. Sachs. 1863, p. 192; De Not. Desm. Ital. 1867, p. 54, t. 5, f. 50; Rabenh. Flor. Europ. Alg. 1868, p. 205; Wolle, Desm. U. S. 1884, p. 124, t. 40, f. 37–39; Cooke,

Brit. Desm. 1887, p. 167, t. 58, f. 1; De Toni, Syll. Alg. 1889, p. 1202; Anders. Sverig. Chlor. 1890, p. 11; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 159, t. 4, f. 53–56; Some N. Amer. Desm. 1896, p. 262, t. 16, f. 32; Alg. S. England, 1897, p. 494; G. S. West, Variation Desm. 1899, p. 391, t. 11, f. 5–15; West & G. S. West, Alg. N. Ireland, 1902, p. 49; Alga-fl. Yorks. 1902, p. 103; Hirn, Desm. Finnland, 1903, p. 20; G. S. West, Brit. Freshw. Alg. 1904, p. 172, f. 65, F.
Phycastrum Ralfsii Kütz. Spec. Alg. 1849, p. 181.
Ph. brachiatum Perty, Kleinst. Lebensf. 1852, p. 210, t. 16, f. 33.

Cells small, about as long (including processes) as broad, deeply constricted, sinus acute and rectangular, minutely excavated at the apex; semicells somewhat triangular, apex and sides nearly straight, angles produced to form stout divergent processes of variable length, which are 2–3-fid at the apex. Vertical view 3–5-angular, sides strongly concave, sometimes with a very slight median inflation; processes hollow to the extreme tip.

Zygospore irregular and variable in outline, sometimes quadrangular, with a few blunt processes.

Length 27–36·5 μ; breadth 25–48 μ; breadth of isthmus 5–9 μ; diam. zygosp., without processes, 21–30 μ.

England.—Westmoreland, and in the plankton of Easedale Tarn! W., N., and E. Yorks! Gloucester (*Ralfs*). Surrey (zygospores from Thursley Common)! Devon (*Harris*)! Cornwall (*Ralfs*).

Wales.—Capel Curig (*Cooke & Wills*)!, Moel Siabod, Llyn Idwal, near Conway, and Llyn Teyrn. Snowdon, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

Scotland.—Ross!, Inverness!, Aberdeen, Kincardine, Forfar, Perth!, Argyle, Arran; zygospores from Curran and Clochnaben, Kincardine (*Roy & Biss.*). Sutherland! Somewhat rare in the plankton! Lewis, Outer Hebrides, and in the plankton! Shetlands, and in the plankton of the Orkneys and Shetlands!

Ireland.—Mayo! Donegal! Galway, and in the plankton! Kerry, and in the plankton! Dublin and Wicklow (*Arch.*). Down!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Galicia in Austria. Hungary. Italy.

Norway. Sweden. Denmark. Finland. Faeroes. W. Greenland. Japan. Australia. Azores. United States. Guiana (var.). Colombia.

St. brachiatum is a frequent inhabitant of *Sphagnum* bogs, and is sometimes obtained in abundance from such localities. It is often found in plankton, but never occurs in great numbers in this habitat. It is one of the most variable of Desmids, particularly with regard to the relative length and stoutness of the processes and the character of their apices. The processes may be fairly long and slender, or sometimes quite short and stout, whilst their apices may be 2- or 3-fid, both types occurring occasionally in the same individual; or the ultimate divisions may be bluntly rounded, and in extreme cases wanting altogether. The semicells are frequently twisted so that corresponding angles do not overlie each other.

107. **Staurastrum lævispinum** Bissett.

(Pl. CXLI, figs. 17, 18.)

St. lævispinum Biss. Desm. Windermere, 1884, p. 195, t. 5, f. 5; Cooke, Brit. Desm. 1887, p. 143, t. 50, f. 3; De Toni, Syll. Alg. 1889, p. 1144; Roy & Biss. Scott. Desm. 1893, p. 22; West & G. S. West, Alg. N Ireland, 1902, p. 49, t. 2, f. 37; Brit. Freshw. Phytoplankton, 1909, p. 202.

Cells small, sinus obtuse and nearly rectangular, with a minute excavation at its apex; semicells somewhat lunate, angles produced into thick, slightly divergent processes, which are slightly attenuated towards their obtuse apices; apex of semicell concave. Vertical view triangular, sides concave, angles produced and tapering. Zygospore unknown.

Length 25–30 μ; breadth 32–39 μ; breadth of isthmus 9 μ.

ENGLAND.—Near Bowness, Westmoreland (*Biss.*). Dartmoor, Devon (*Harris*).

SCOTLAND.—Goat Fell, Arran (*Roy & Biss.*). Plankton of Loch nan Eun, N. Uist, Outer Hebrides!

IRELAND.—E. of Glenties; Lough Anna and Sproules Lough, Donegal (form)!

Geogr. Distribution.—Australia (form).

The specimens figured on Pl. CXLI, f. 18, from Ireland are not exactly typical, being more or less intermediate in form between *St. lævispinum* and the next described species, *St. sublævispinum*. The processes are less attenuated and not so divergent as in typical *St. lævispinum* and the "body" of the cell is not quite as large. They have more in common with *St. lævispinum*, however, than with *St. sublævispinum*.

108. **Staurastrum sublævispinum** W. & G. S. West.

(Pl. CXLI, fig. 19.)

St. sublævispinum West & G. S. West, Desm. U. S. 1898, p. 314, t. 18, f. 20–22; Alg. Ceylon, 1902, p. 179; Further Contrib. Plankt. Scott. Lochs, 1905, p. 502, t. 7, f. 23.

Cells small, $1\frac{1}{2}$ times broader than long (including the processes), deeply constricted, sinus open and obtuse; semicells with a very small "body," angles produced into finger-like strongly diverging processes, with parallel sides and conical apices; apex of semicell concave. Vertical view triangular, "body" small, and processes stout. Cell-wall smooth.

Zygospore unknown.

Length 25–33 μ; breadth 37–46 μ; breadth of isthmus 7–8·5 μ.

SCOTLAND.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Geogr. Distribution.—Ceylon. United States.

St. sublævispinum is closely related to *St. lævispinum*, from which it is distinguished by its relatively greater breadth, and smaller "body" of the semicell; its processes are cylindrical and only abruptly attenuated at the apex.

109. **Staurastrum subnudibrachiatum** W. & G. S. West.

(Pl. CXLI, fig. 20.)

St. subnudibrachiatum West & G. S. West, Further Contrib. Freshw. Phytoplankton Scott. Lochs, 1905, p. 502, t. 7, f. 18, 19.

Cells of medium size, about $1\frac{1}{2}$ times broader than long, including the processes, body of cell slightly con-

stricted, sinus very widely open, semicells subspherical; lateral margins produced into long, straight, and smooth processes, which diverge from those of the other semicell; apex of processes usually forked into two obtuse teeth, but sometimes entire and obtuse. Vertical view 4–5-radiate, processes as long as the "body" of the semicell; cell-wall smooth; processes of one semicell alternating with those of the other. Chloroplast axile with a large central pyrenoid.

Zygospore unknown.

Length, without processes, 31–37 μ; with processes, 40–44 μ; breadth, without processes, about 20–22 μ; with processes, 53–61 μ; breadth of isthmus 15–15·5 μ.

SCOTLAND.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

St. subnudibrachiatum is very similar to *St. brachiatum* Ralfs in the nature of its processes, but it differs widely from that species in the form of its semicells, and its slight constriction. The processes are variable in character, even in the same specimen. They are usually bifurcate at the extremity, each lobe being rounded, but sometimes they are obtuse and entire.

It also has some superficial resemblances to *St. Clevei* (Wittr.) Roy & Biss., from which it is readily distinguished by its broader isthmus, by the rounded apical teeth of the processes, and by the fact that the latter lie all in the same plane.

110. **Staurastrum læve** Ralfs.

(Pl. CXLI, figs. 1–3.)

St. læve Ralfs, Brit. Desm. 1848, p. 131, t. 23, f. 10; Arch. in Pritch. Infus. 1861, p. 743; Rabenh. Krypt. Flor. Sachs. 1863, p. 193; Flor. Europ. Alg. 1868, p. 206; Wittr. Gotl. Öl. sötv. Alg. 1872, p. 54; Kirchn. Alg. Schles. 1878, p. 167; Cooke, Brit. Desm. 1887, p. 180, t. 63, f. 2; Hansg. Prodr. Algenfl. Böhm. 1888, p. 212; De Toni, Syll. Alg. 1889, p. 1227; Roy & Biss. Scott. Desm. 1893, p. 22; West & G. S. West, Alg. S. England, 1897, p. 494; Comère, Desm. de France, 1901, p. 152, t. 11, f. 14; West & G. S. West, Alga-fl. Yorks. 1902, p. 104; Gutw. Alg. Ins. Java, 1902, p. 606.

Cells very small, about $1\frac{1}{3}$ times longer than broad, not including the processes, deeply constricted, sinus

acute and rectangular, minutely excavated at its apex; semicells elliptical or subsemicircular, dorsal margin only slightly convex, ventral margin very tumid; each angle of the semicell with a pair of short smooth processes, all lying in the same horizontal plane, very slightly divergent; apices of processes bifid, with the two teeth vertically one above the other. Vertical view 3–5-angular, sides strongly concave, angles deeply lobed, each lobe tapering into a short process. Cell-wall smooth. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore spherical, with a number of slender processes which are twice dichotomous at the apex.

Length, with processes, 22–27·5 μ; breadth 23–28 μ; breadth of isthmus 7–8 μ; diam. zygosp., without processes, 18 μ; with processes, 30–35 μ.

ENGLAND.—Near Bowness, Westmoreland (*Bissett*). Strensall Common (*W. B. Turner*) and Pilmoor, N. Yorks (very abundant and with zygospores)! Thursley Common, Surrey (very abundant)! Dartmoor (*Harris*).

WALES.—Capel Curig, Carnarvonshire (*Cooke & Wills*). Outlet of Llyn Gwernan, Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Loch Inver, Sutherland; Birsemore Loch, near Loch Dawan and Tomacher, Aberdeen; near Durris Bridge, Kincardine (*Roy & Biss.*).

IRELAND.—Achill Isle, Mayo! Adrigole, Co. Cork!

Geogr. Distribution.—France. Germany. Galicia in Austria. Norway. Sweden. Denmark. Bornholm. Java. Australia. United States. Brazil.

SECTION I.

Processes rough, denticulate or spinate along their whole length.

* Cells without prominent accessory spines on "body" of cell, which, at the most, is rough with tiny granules or more acute denticulations, never bearing spines of any great length.

† Cells with one process only at each angle of the cell.

‡ Cells not more than four times as long as broad, excluding the processes.

§ Cells in vertical view 2–5-radiate; if more than 4-radiate, processes relatively short.

a. Faces of semicell smooth or provided with granules or small denticulations; conspicuous verrucæ never present except on the apex of the semicell.

A. Processes well developed, at least as long as the body of the cell is broad, and frequently longer; semicells usually distinctly cuneate or cup-shaped, bearing the processes at the upper angles of the cells.

1. Cells fairly large, more than $20\,\mu$ long excluding the processes.

111. *St. gracile.*
112. *St. paradoxum.*
113. *St. pseudopelagicum.*
114. *St. inflexum.*
115. *St. crenulatum.*
116. *St. neglectum.*
117. *St. dubium.*
118. *St. boreale.*
119. *St. Pseudosebaldi.*
120. *St. Manfeldtii.*
121. *St. Duacense.*
122. *St. bicorne.*

2. Cells small, less than $20\,\mu$ long, excluding the processes.

123. *St. subgracillimum.*
124. *St. tetracerum.*
125. *St. iotanum.*
126. *St. pseudotetracerum.*
127. *St. micron.*
128. *St. latiusculum.*

B. Processes only feebly developed, not as long as the body of the cell is broad.

1. Processes solid, deeply bifid at their apices.

129. *St. pelagicum.*

2. Processes hollow for their whole length.

I. Dorsal margin of the semicell less convex than the ventral; semicells more or less cup-shaped.

! Processes straight, arising from the upper angles of the cell.

130. *St. polymorphum.*
131. *St. affine.*
132. *St. proboscidium.*
115. *St. crenulatum.*
133. *St. margaritaceum.*
134. *St. Chavesii.*

!! Processes strongly inflexed.

135. *St. cyrtocerum.*
136. *St. brachycerum.*
137. *St. eboracense.*

II. Dorsal and ventral margins almost equally convex: semicells subfusiform.

138. *St. hexacerum.*
139. *St. Haaboeliense.*

b. Faces of semicell provided with large and prominent verrucæ, often flattened and complex, either on a central protuberance (in the biradiate forms), or in definite series.

140. *St. Cerastes.*
141. *St. anatinum.*
142. *St. sexcostatum.*
143. *St. natator.*
144. *St. irregulare.*

§§ Cells in vertical view usually 5–9 rayed, processes nearly twice as long as the " body " of the cell is broad, and radiating like the spokes of a wheel.

145. *St. Arachne.*
146. *St. Ophiura.*
147. *St. verticillatum.*
148. *St. Archeri.*

‡‡ Cells 6 times as long as broad, excluding the processes.

149. *St. elongatum.*

†† Cells with 2 processes at each angle, all lying in the same horizontal plane.

150. *St. barbaricum.*

** Cells with prominent accessory spines, either simple or emarginate, but of considerable length, on the "body" of the cell.

151. *St. vestitum.*
152. *St. aculeatum.*
153. *St. controversum.*
154. *St. cosmospinosum.*
155. *St. Heimerlianum.*
156. *St. Sebaldi.*
157. *St. oxyacanthum.*
158. *St. dorsidentiferum.*
159. *St. aciculiferum.*

111. **Staurastrum gracile** Ralfs.

(Pl. CXLIV, figs. 3–7.)

Staurastrum gracile Ralfs, in Ann. Mag. Nat. Hist. 1845, p. 155, t. 11, f. 3; Brit. Desm. 1848, p. 136, t. 22, f. 12; Arch. in Pritch. Infus. 1861, p. 742, t. 3, f. 28, 29; Rabenh. Krypt. Flor. Sachs. 1863, p. 192; De Not. Desm. Ital. 1867, p. 54, t. 5, f. 49; Rabenh. Flor. Europ. Alg. 1868, p. 211; Arch. in Quart. Journ. Micr. Sci. v. 10. 1870, p. 86; Nordst. Norges Desm. 1873, p. 74; Jacobs. Desm. Danem. 1875, p. 207; Delp. Spec. Desm. subalp. 1877, p. 153, t. 12, f. 12–21; Kirchn. Alg. Schles. 1878, p. 167; Wolle, Desm. U. S. 1884, p. 133, t. 43, f. 16, 17; Cooke, Brit. Desm. 1887, p. 170, t. 58, f. 6; De Toni, Syll. Alg. 1889, p. 1209; Anderss. Sverig. Chloroph. 1890, p. 12; West, Alg. W. Ireland, 1892, p. 181; Roy & Biss. Scott. Desm. 1893, p. 20; West & G. S. West, Alg. S. England, 1897, p. 495, t. 6, f. 27; Desm. U. S. 1898, p. 317, t. 18, f. 7; Alg. N. Ireland, 1902, p. 54; Alga-fl. Yorks. 1902, p. 105; Alg. Ceylon, 1902, p. 190; Scott. Freshw. Plankt. I, 1903, p. 549, t. 18, f. 10; Freshw. Alg. Orkneys & Shetlands, 1905, p. 27; Teodoresco, Matér. flor. Alg. Roumania, 1907, p. 186; Kofoid, Plankt. Illinois, 1908, p. 61; Gutw. Flor. Alg. Mont. Tatr. 1909, p. 475; Wahlburg, Bidr. känne. Littois-trask, 1913, p. 47, t. 1, f. 7.
Phycastrum gracile Kütz. Spec. Alg. 1849, p. 181.
Didymidium (Staurastrum) gracile Reinsch, Algenfl. Frank. 1867, p. 166.

Cells variable, usually of small or medium size, 2–2½ times longer than broad, excluding the processes; constriction slight, usually an acute notch: semicells variable in form, usually more or less cup-shaped, lower angles broadly rounded, lateral margins nearly vertical or slightly diverging, rarely slightly concave, semicells usually broadening slightly towards the apex, which is very slightly convex; upper angles produced to form long slender processes of variable length, each tipped with 3 or 4 minute spines, and provided with several concentric series of denticulations; processes

usually horizontal, sometimes slightly converging. Vertical view usually triangular, sometimes quadrangular; sides straight or rarely slightly concave, angles produced to form long processes, lateral margins often with a series of minute granulations, sometimes paired, just within the margin. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore spherical, provided with numerous spines, broad at the base, and once or twice divided at the apex.

Length 27–60 μ; breadth, including processes, 44–110 μ; breadth of isthmus 5·5–13 μ; diam. zygosp., without processes, 32 μ; with processes, 60 μ.

ENGLAND.—Cumberland, and in the plankton of Buttermere! Westmoreland! Lancashire! (*Ralfs*). W., N., and E. Yorks., and in the plankton of Gormire, N. Yorks! Leicestershire (*Roy*). Essex! Burnham Beeches, Bucks! Oxford! Surrey (zygospores from Thursley Common)! Hants! (*Roy*). Devon! (*Harris*). Cornwall!

WALES.—Fairly general (at 2200 feet on Glyder Fach)! In the plankton!

SCOTLAND.—Sutherland!, Ross!, Inverness!, Aberdeen, Kincardine, Forfar, Perth!, Argyle and Fife (*Roy & Biss.*). Cumbrae, Ayr! Near Lochmaddy, N. Uist, and in Lewis and Harris, Outer Hebrides! Orkneys and Shetlands, also in the plankton! More or less general in the plankton!

IRELAND.—Donegal! Mayo and Clare Isle, and in the plankton of Mayo! Galway and in the plankton! Kerry and in the plankton! Dublin and Wicklow (*Arch.*). Plankton of Lough Neagh! Londonderry!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Roumania. Italy. Norway. Finmark. Sweden. Denmark. Bornholm. Finland. Poland. N. Russia. Caucasus. Greenland. Siberia. Mongolia. Central China (var.). Japan. Turkey in Asia. Ceylon. Australia. Madagascar (var.). E., Central, and S. Africa. United States. Canada. Brazil. Paraguay.

St. gracile is one of the most widely distributed and, at the same time, most variable of Desmids, being variable both in the form of its semicells, and the relative proportions of its " body " and processes. It is very closely allied to *St. paradoxum* Meyen, and it is sometimes very difficult to distinguish between the two species. The chief difference between them is that the processes of *St. gracile* are horizontal or slightly converging in the front view, whereas in *St. paradoxum* they are usually shorter in proportion and divergent. The strength of the granulation is also variable in this species. The granules are usually stronger on the processes, and, if present on the "body" of the semicell, they are very minute and little more than punctulations. The plankton forms are often much larger than usual, and deviate considerably from the typical form. The specimen figured on Pl. CXLIV, fig. 6, is a peculiar plankton form with processes tapering from a very broad base, and the apical granules so strongly developed as to be almost spines. Pl. CXLIV, fig. 3 is a rather puzzling Desmid which was identified by Prof. G. S. West as *St. gracile* in spite of its slightly divergent processes.

Var. **bicorne** Bulnh.

St. gracile var. *bicorne* Bulnh. in Hedwigia, 1861, p. 51, t. 9, f. 2; Arch. in Quart. Journ. Micr. Sci. 1870, p. 86; Jacobs. Desm. Dane. 1875, p. 207; De Toni, Syll. Alg. 1889, p. 1209; Roy & Biss. Scott. Desm. 1893, p. 20.

Cells in front view similar to the type; in end view broadly fusiform, elongated at the poles to form processes.

Length 31·3–32·5 μ; breadth, including processes, 52·5–57·5; thickness 15 μ; breadth of isthmus 12·5 μ.

Scotland.—Upper Powlair, Slewdrum, Birsemore Loch, Craigendinnie, Heughhead, west of the Ord, near Loch Dawan, Homehead, Birkhill and Mosston Moor, Aberdeen; Scolty Dam and Dalbrake, Kincardine; Fowlis Wester, Perth (*Roy & Biss.*).

Ireland.—Mullingar, Co. Westmeath (*Archer*).

Geogr. Distribution.—Germany. Norway. Sweden. Denmark. Finland.

Var. **bulbosum** West. (Pl. CXLIV, fig. 13.)

St. gracile subsp. *bulbosum* West, Alg. W. Ireland, 1892, p. 182, t. 23, f. 11.
St. gracile var. *bulbosum* West & G. S. West, Alg. N. Ireland, 1902, p. 54.

Semicells, excluding the processes, relatively a little longer than in the type, slender and campanulate, gracefully inflated at the base ; sinus deeper than usual, and almost linear ; processes long and slender, bifid at the apex ; in vertical view triangular, with a series of small granules within the lateral margins.

Length 52 μ ; breadth, including processes, 95 μ ; breadth at base of semicell 18 μ ; breadth of isthmus 11 μ.

IRELAND.—Lough Darragh, Donegal ! Derryclare Lough, Galway !

The chief distinction between var. *bulbosum* and the typical form seems to be the gracefully swollen base of the semicell. Intermediate stages, however, do occur. For example the peculiar specimen figured on Pl. CXLIV, fig. 6 from the plankton of Loch Doon shows a tendency to cylindrical form of the body of the semicell with slightly inflated base.

Var. **cyathiforme** W. & G. S. West. (Pl. CXLIV, fig. 12.)

St. gracile var. *cyathiforme* West & G. S. West, Freshw. Alg. Madag. 1895, p. 77, t. 9, f. 2 ; Welw. Afric. Alg. 1897, p. 182 ; Furth. Contrib. Plankton Scott. Lochs, 1905, p. 504.

Semicells cyathiform, slightly swollen at the base, lateral margins undulate and denticulate, apex of semicell convex, with a row of emarginate verrucæ continued as smaller teeth along the dorsal margin of the processes, which are tipped with a few small spines ; vertical view with a series of emarginate verrucæ within each lateral margin ; cell-wall punctate.

Length 52–58 μ ; breadth, including processes, 80–88 μ ; breadth of isthmus 8–15 μ.

SCOTLAND.—Plankton of Lochs an Sgath and Fadaghoda, Lewis, Outer Hebrides !

IRELAND.—Plankton of Loch Currane, Kerry !

Geogr. Distribution.—Central China (form). Madagascar. W. Africa.

The British examples of this variety differ from the originally

described specimens from Madagascar in that the sides of the semicells are simple, without denticulations or undulations, and the apical teeth of the processes are considerably larger.

Var. **coronulatum** Boldt. (Pl. CXLIV, fig. 10.)

St. gracile var. *coronulatum* Boldt, Sibir. Chlorophy. 1885, p. 116, t. 5, f. 28; De Toni, Syll. Alg. 1889, p. 1209; West, Alg. Engl. Lake Distr. 1892, p. 20, t. 9, f. 36; Lütkem. Desm. Attersees, 1893, p. 567.

Cells sometimes rather smaller than in the type, often more depressed and with slightly shorter processes; apex of semicell slightly convex, with two emarginate processes at the top of each face; vertical view triangular or quadrangular, with two emarginate verrucæ within each lateral margin.

Length 21–36 μ; breadth, including processes, 32·5–43 μ; breadth of isthmus 6–11 μ.

England.—Bowness, Westmoreland!

Geogr. Distribution.—Germany. Austria. Siberia.

Var. **tenuissima** Boldt. (Pl. CXLIV, fig. 11.)

St. gracile var. *tenuissima* Boldt, Sibir. Chlorophy. 1885, t. 5, f. 29 (without description); Roy & Biss. Scott. Desm. 1893, p. 20.

Cells more depressed than in the type; semicells subfusiform, produced at the lateral angles to form processes longer and more slender than usual. Vertical view quadrangular, with 3 tiny granules within each concave margin.

Length 18 μ; breadth, excluding processes, about 14 μ; with processes, 40 μ; breadth of isthmus 6 μ.

Scotland.—In Skye and at Brin, Inverness; Haughton and in Glen Clunie, Aberdeen; Crathes and Glen Dye, Kincardine; Glen Garry, Perth (*Roy & Biss.*).

Geogr. Distribution.—Siberia.

Var. **nanum** Wille. (Pl. CXLIV, figs. 8, 9.)

St. gracile var. *nanum* Wille, Norges Ferskv. Alg. 1880, p. 46, t. 2, f. 31; Racib. Nonn. Desm. Polon. 1885, p. 33, t. 12, f. 6; De Toni, Syll. Alg. 1889, p. 1209; West, Alg. W. Ireland, 1892, p. 182; West & G. S. West,

Alg. S. England, 1897, p. 495; Alga-fl. Yorks. 1902, p. 105; Alg. N. Ireland, 1902, p. 54; Freshw. Alg. Orkneys and Shetlands, 1905, p. 27; Kaiser, Algenfl. Traunstein u. Chiemgau, I, 1914, p. 152.

Cells considerably smaller than in the type, and with much shorter processes; apex of semicell nearly straight or slightly convex; end view 3–5-angular.

Length 14–27·5 μ; breadth, including processes, 23–25 μ; breadth of isthmus 4–8·7 μ.

ENGLAND.—Harrop Tarn, Cumberland! Plankton of Brother's Water, Codale and Easedale Tarns, Westmoreland! Pilmoor, N. Yorks! Skipwith Common, E. Yorks! Near Goring, Oxfordshire! Near Chapel Wood and Bisley Common, Surrey! New Forest, Hants!

WALES.—Capel Curig, Snowdon and Llyn Idwal, Carnarvon!

SCOTLAND.—Rhiconich, Sutherland! Plankton of Loch Bairness, Inverness!, and of Loch Stranabhat, Lewis, Outer Hebrides! Orkneys!

IRELAND.—Donegal! Mayo! Galway! Kerry!

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Finland. Poland. Ceylon.

112. **Staurastrum paradoxum** Meyen.

(Pl. CXLV, figs. 1–5.)

Staurastrum paradoxum Meyer, Beobacht. niedere Alg. 1828, p. 777, t. 43, f. 37, 38; Menegh. Syn. Desm. 1840, p. 227; Ralfs in Ann. Mag. Nat. Hist. v. 15, 1845, p. 151, t. 10, f. 2; Kütz. Phyc. generalis, 1843, p. 163; Ralfs, Brit. Desm. 1848, p. 138, t. 23, f. 8; Arch. in Pritch. Inf. 1861, p. 742; Rabenh. Krypt. Flora Sachs. 1863, p. 191; Flor. Europ. Alg. 1868, p. 210; Delp. Spec. Desm. subalp. 1877, p. 56, t. 11, f. 63–65; Kirchn. Alg. Schles. 1878, p. 167; Wolle, Desm. U. S. 1884, p. 129, t. 42, f. 36, 37; Cooke, Brit. Desm. 1887, p. 171, t. 59, f. 4; Nordst. Freshw. Alg. N. Zealand, 1888, p. 38, t. 4, f. 10, 11; De Toni, Syll. Alg. 1889, p. 1211; Turn. Freshw. Alg. E. India, 1893, p. 125, t. 15, f. 4, a, b, d, and e; Roy & Biss. Scott. Desm. 1893, p. 23; West & G. S. West, Alg. S. England, 1897, p. 496; Comère, Desm. de France, 1901, p. 157, t. 11, f. 19; West & G. S. West, Alga-fl. Yorks. 1902, p. 106; Von Keissler, Plankt. Hallst. Sees, 1903, p. 338; West & G. S. West, Scott. Freshw. Plankton, 1903, p. 548, t. 18, f. 4, 5; Freshw. Alg. Orkneys & Shetlands, 1905, p. 27, t. 2, f. 33–35, Ostenf. & Wesenberg-Lund, Fortnightly Expl. Plankt. Icel. Lakes, 1906, p. 1112, t. 25, f. 14; W. & G. S. West, Brit. Freshw. Phytopl. 1909, p. 175.

Micrasterias Staurastrum Kütz. Syn. Diat. 1834, p. 71.

Phycastrum paradoxum Kütz. Phyc. Germ. 1845, p. 138 (in part); Spec. Alg. 1849, p. 180 (in part).

Ph. tridens Kütz. Spec. Alg. 1849, p. 180 (in part).

Ph. (*Stenactinium*) *paradoxum* Näg. Gatt. einz. Alg. 1849, p. 128.
Didymidium (*Staurastrum*) *paradoxum* Reinsch, Alg. Frank. 1867, p. 164 (in part).

Cells of small or medium size, $1\frac{1}{2}$–$2\frac{1}{2}$ times longer than broad, excluding the processes; constriction moderately deep, sinus acute; semicells cup-shaped or cuneate, lower angles broadly rounded, semicells becoming wider towards the apex, which is nearly flat, upper angles produced to form fairly long tapering and diverging processes, tipped with 3 or 4 spines of varying size, and provided with numerous series of denticulations. Vertical view usually 3- or 4-angular, sides straight or very slightly concave, angles produced into long processes, centre of apex quite smooth, sometimes with a series of short spines or granules just within each lateral margin. Chloroplast axile, with a central pyrenoid in the centre of each semicell and a pair of lobes extending into each angle.

Zygospore globular, not large, with few long spines, 2–3-fid at the apex (*Roy & Bissett*).

Length 21–36 μ; breadth, including processes, 41–70 μ; breadth of isthmus 5–12 μ.

ENGLAND.—Cumberland, and in the plankton of Buttermere, Crummock Water, Derwentwater and Wast Water! Westmoreland, and in the plankton of Red Tarn, Grasmere and Windermere! W., N., and E. Yorks! Oxfordshire! Plankton of pools in Sutton Park, Warwickshire! Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Hants! (*Roy*). Devon (*Harris*). Cornwall!

WALES.—Bethesda!, Capel Curig! (*Cooke & Wills*), Llandudno!, Llyn Bochlwyd!, Bettws-y-coed (*Roy*), Llyn-y-cwm-ffynon! and Glyder Fach!, Carnarvonshire. Llyn Coron!, Anglesea, and Holyhead!

SCOTLAND.—General, zygospore from Kerloch, Kincardine (*Roy & Biss.*). Lewis and Harris, Outer Hebrides! Orkneys and Shetlands, and in the plankton! Common in the general plankton!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*). Down! Plankton of Mayo

and Achill Isle, Galway, Kerry, and Lough Beg, Londonderry!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Norway. Sweden. Denmark. Bornholm. Finmark. Poland. N. and S. Russia. Faeroes. Iceland. Greenland. Siberia (var.). Japan. Turkey-in-Asia. Australia. United States. Canada. Guiana. Brazil. Patagonia.

The nearest relative of *St. paradoxum* is *St. gracile.* From the latter species it is distinguished chiefly by its divergent processes. Both species are subject to considerable variation, and transitional forms between the two species are not infrequent, in consequence of which specimens are occasionally encountered which cannot with any degree of certainty be referred either to the one species or to the other. Even amongst the collections of Professor West are some gatherings labelled with a query. This proves that the identification of some forms is impossible.

The divergence of the processes is not usually very great in the typical form, but some specimens from plankton have processes which are more divergent, and very often relatively longer as well. Other plankton forms bear a superficial resemblance to *St. pseudopelagicum.* The strength of the granulation varies, as does also the length of the apical spines of the processes. Sometimes the granules at the base of the processes become strengthened into short spines, and in some cases there is a row of such spines just within each lateral margin in the end view. The "body" of the semicell is usually quite smooth.

St. paradoxum is quite a common species in this country, and has a world-wide distribution. The biradiate form has been recorded from the plankton of Bracebridge Pool, Sutton Park, Warwicks.

Var. **longipes** Nordst. (Pl. CXLVI, figs. 2, 3.)

St. paradoxum var. *longipes* Nordst. Norges Desm. 1873, p. 35, t. 1, f. 17; Cooke, Brit. Desm. 1887, p. 171, t. 59, f. 4; De Toni, Syll. Alg. 1889, p. 1212; West, Alg. N. Wales, 1890, p. 18; Turn. Freshw. Alg. E. India, 1893, p. 125, t. 4, f. 4 c and f; Roy & Biss. Scott. Desm. 1893, p. 23; Borge, Schwed. Süsswasserplankton, 1900, p. 6, t. 1, f. 4; Lütkem. Desm. Central China, 1900, p. 124; West & G. S. West, Alga-fl. Yorks. 1902, p. 106; Hirn, Desm. Finnland, 1903, p. 22; West & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, p. 504; British Freshw. Phyto-

plankton, 1909, p. 172; Wahlburg, Bidr. känne. Littois-trask, 1913, p. 48.

Body of semicell smaller and relatively somewhat narrower than in the type, processes very much longer and very slender, rather more divergent and often gracefully curved, about $1\frac{1}{2}$ times to twice as long as the body of the cell.

? Zygospore globose and smooth, fuscous brown in colour (*Turner*).

Length, without processes, 26–29 μ; with processes, 77–84 μ; breadth, without processes, 15–17 μ; with processes, 84–139 μ; breadth of isthmus 8–9·5 μ; diam. zygosp. 12 μ (*Turn.*).

ENGLAND.—Plankton of Crummock Water, Cumberland! Plankton of Hawes Water, Grasmere, Stickle Tarn and Windermere, Westmoreland! Strensall, N. Yorks! Plankton of pools in Sutton Park, Warwickshire!

WALES.—Capel Curig! (*Cooke & Wills*), Carnarvonshire. In the plankton!

SCOTLAND.—Loch Hempriggs, Caithness!; Poolewe, Ross; Dallas, Moray; Glen Coe, Argyle (*Roy & Biss.*). Rhiconich, Sutherland! Loch Ness, Inverness! Common in the plankton of Sutherland, Ross, Inverness, Perth, Lewis and Harris, Outer Hebrides, and of the Orkneys and Shetlands!

IRELAND.—Donegal! Galway! Kerry! Plankton of Mayo, Galway, Kerry, Lough Neagh, and of Lough Beg, Londonderry!

Geogr. Distribution.—Germany. Galicia and Austria. Servia. Norway. Sweden. Finland. Poland. Iceland. Central China. Turkey-in-Asia. Australia. Canada. Colombia.

This variety is most commonly found in plankton, although not exclusively confined to such a habitat. It is a frequent constituent in plankton samples from many parts of the world, and is generally distributed in the British lakes, occurring in some cases in such great abundance as to form the dominant constituent of the phytoplankton.

The zygospore figured by W. B. Turner, 1893, for this variety

does not correspond at all with the description given by Roy & Bissett for the zygospore of the type. It is evident that if both these records be accurate, var. *longipes* should not be placed as a variety of *St. paradoxum*, but, because of its very different zygospore, should be considered a distinct species. Whilst further knowledge of the zygospores is to be desired before coming to a definite conclusion, the writer is inclined to the opinion that the zygospore figured by Turner quite possibly did not belong to *St. paradoxum* var. *longipes* Nordst.

Var. **cingulum** West & G. S. West. (Pl. CXLV, figs. 9, 10.)

St. paradoxum var. *cingulum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 548, t. 18, f. 6, 7.

Base of semicell subcylindrical and narrower than in the type, and with a ring of about 12 minute papillæ, of which 7 are visible across the base in the front view; apex of semicell straight or slightly convex; processes longer and more slender than in the type, gracefully curved upwards.

Length, without processes, 32–40 μ; including processes, 71–81 μ; breadth, without processes, 16–23 μ; including processes, 64–77 μ; breadth at base of semicell, 11·5–12 μ; breadth of isthmus 7·5–8·5 μ.

ENGLAND.—Plankton of Hawes Water, Westmoreland!

WALES.—In the plankton.

SCOTLAND.—Plankton of Lochs Shin and Morar, Sutherland!, Loch Rosque, Ross!, Lochs Katrine and Achray, Perth!, and in the plankton of the Orkneys and Shetlands!

IRELAND.—Plankton of Loch Currane, Kerry!

Geogr. Distribution.—Norway. Australia.

This variety is exclusively confined to plankton, and is not at all universal in its distribution. It is distinguished by the narrow cylindrical base of the semicells, furnished with a ring of about a dozen minute spines. The processes are longer than in the typical form and are gracefully curved upwards. The body of the semicell is frequently covered with small granules, similar to those on the processes and arranged in concentric rings round the base of each process. In length and in curvature

the processes are similar to those of *St. paradoxum* var. *longipes* Nordst.

Var. **nodulosum** West. (Pl. CXLVI, fig. 1.)

St. paradoxum var. *nodulosum* West, Alg. W. Ireland, 1892, p. 182, t. 23, f. 13.

A smaller variety with its processes trifurcate at the apices; cells in vertical view triangular, lateral margins with two undulations.

Length with processes, 33 μ; without processes, 14 μ; breadth, with processes, 27·5–30 μ; breadth of isthmus 5 μ.

IRELAND.—Upper Lake of Killarney, Kerry!

Var. **parvum** West. (Pl. CXLV, fig. 6.)

St. paradoxum forma *parva* West, Alg. W. Ireland, 1892, p. 182, t. 23, f. 12; Roy & Biss. Scott. Desm. 1894, p. 23; West & G. S. West, Alg. S. England, 1897, p. 496.

? *St. paradoxum* var. *longipes* forma *minor* Istvanffi, Diag. præv. Alg. nov. Hungar. 1887, p. 11.

Cells similar to the type form but exceedingly minute.

Length, without processes, 9–16 μ; with processes, 18–35 μ; breadth, with processes, 20–28 μ; breadth of isthmus 3·5–6 μ.

ENGLAND.—Thursley Common, Surrey! Keston Common, Kent! New Forest, Hants!

SCOTLAND.—Common (*Roy & Biss.*). Rhiconich, Sutherland!

IRELAND.—Near Glenties and Sproule's Lough, Donegal! Ballynahinch, Galway! Adrigole, Cork!

Geogr. Distribution.—Finland. Hungary?

The dimensions given by Istvanffi for his *St. paradoxum* var. *longipes* forma *minor* agree with those of var. *parvum* West, and forma *minutissima* of Heimerl ('Desm. alpin.' 1891, p. 607) also seems to be very similar to this variety. Figures were in neither case given, unfortunately; but Schmidle's figure of forma *minutissima* Heimerl ('Beitr. Alg. Alp.' 1895, t. 16, f. 16) does not exactly correspond with var. *parvum* West. It is possible, however, that both f. *minor* Istv. and f. *minutissima* Heimerl are synonymous with var. *parvum* West.

Var. **evolutum** W. & G. S. West. (Pl. CXLV, figs. 7, 8.)

St. tetracerum var. *evolutum* West & G. S. West, Freshw. Alg. Orkneys & Shetlands, 1905, p. 25, t. 2, f. 31.
St. paradoxum var. G. S. West in manuscript.

Cells very small, about $1\frac{1}{2}$ times longer than broad, excluding the processes, with a minute excavation at the sinus; processes long, diverging and often curved; in vertical view triangular, sides distinctly convex, angles produced into long processes.

Length, without processes, 10–11 μ; with processes, 27–40 μ; breadth, without processes, 7·5–9·5 μ; with processes, 26–50 μ; breadth of isthmus 4·5 μ.

SCOTLAND.—In the plankton, Shetlands!

This variety is distinguished from var. *longipes* Nordst. by its much smaller size, and its semicells of different proportions, as well as by its convex sides in the vertical view. The latter character and the longer processes readily distinguish it also from var. *parvum* West. The length of the processes is subject to considerable variation, and the cells are invariably twisted so that the angles of the one semicell alternate with those of the other.

113. **Staurastrum pseudopelagicum** W. & G. S. West. (Pl. CXLV, figs. 11, 12.)

St. pseudopelagicum West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 547, t. 18, f. 1–3; Further Contrib. Freshw. Phytoplank. Scott. Lochs, 1905, p. 504; Freshw. Alg. Orkneys & Shetlands, 1905, p. 27.
St. pseudopelagicum var. *bifurcatum* Huitfeldt-Kaas, Plankton Norske Vande, 1906, p. 154, t. 2, f. 34, 35.

Cells rather under medium size, about $1\frac{1}{4}$ times broader than long, including the processes, deeply constricted; sinus open, acuminate at its apex; semicells obversely semicircular, apex only very slightly convex, angles produced to form short, stout, diverging processes tipped with 2 strong diverging spines; cell-wall rough with granules arranged in concentric series round the processes; vertical view triangular, sides slightly con-

cave or convex, angles produced to form short thick processes.

Zygospore unknown.

Length, without processes, 27–34·5 μ ; with processes, 57–71 μ ; breadth, without processes, about 20–30 μ ; with processes, 63–86·5 μ ; breadth of isthmus 7·5–13 μ.

ENGLAND.—Plankton of Stickle Tarn and Windermere, Westmoreland !

WALES.—In the plankton !

SCOTLAND.—Plankton of Lochs Shin, Morar and Ruar, Sutherland ! Loch Shiel, Inverness ! Loch Tay, Perth ! Loch Stranabhat and 7 other lochs in Lewis, and in Loch a Bhursta, Benbecula, Outer Hebrides ! Plankton of Loch Kirbister, Orkneys.

IRELAND.—Plankton of Lough Gall, Achill Isle, Mayo ! Kerry !

Geogr. Distribution.—Norway. Canada.

This species may be compared with some forms of *St. paradoxum* Meyen, but it is readily distinguished by its shorter processes, which are terminated by two large divergent spines in the same vertical plane.

St. pseudopelagicum var. *bifurcatum* Huitfeldt-Kaas has precisely the same characters as typical *St. pseudopelagicum*. The form mentioned by the same author as typical *St. pseudopelagicum*, the processes of which, according to him, are terminated by 3 spines each, is possibly a form of *St. paradoxum* Meyen. Some of the British specimens, however, have been observed by Prof. G. M. Smith of Wisconsin, U.S.A., to possess processes which end in 3 spines, and on one occasion the processes were tipped with one spine only. The species has so far only been found in plankton.

114. **Staurastrum inflexum** Bréb.

(Pl. CXLIII, figs. 7, 8.)

Staurastrum inflexum Bréb. Liste Desm. 1856, p. 140, t. 1, f. 25 ; Arch. in Pritch. Infus. 1861, p. 742 ; Cooke, Brit. Desm. 1887, p. 169, t. 58, f. 5 ; De Toni, Syll. Alg. 1889, p. 1208 ; West, Alg. Engl. Lake Distr. 1892, p. 20 ; Roy & Biss. Scott. Desm. 1894, p. 21 ; West & G. S. West, Alg. S. England, 1897, p. 495 ; Alga-fl. Yorks. 1902, p. 105.

St. margaritaceum var. *inflexum* Rabenh. Flor. Europ. Alg. 1868, p. 207.

Cells small, about $1\frac{1}{4}$ times broader than long, including the processes, deeply constricted, sinus rectangular, widely open; semicells subcuneate, ventral margin tumid, much more convex than the dorsal, semicells gradually attenuated at the angles to form long, slender, slightly incurved processes, tipped with 2 or 3 very minute spines and provided with several concentric series of minute denticulations. Vertical view triangular, sides concave, angles produced into slender denticulate processes, and with a row of tiny granules just within each lateral margin. Cells often twisted about the isthmus, so that the processes of one semicell alternate with those of the other.

? Zygospore spherical, with numerous slender processes twice dichotomous at the apex.*

Length 21·7–26 μ; breadth, without processes, 14–15 μ; including processes, 30–40 μ; breadth of isthmus 5–7·5 μ.

ENGLAND.—Westmoreland! (*Biss.*), and in the plankton of Codale Tarn! Lancashire! W. & N. Yorks! Cheshire and Leicester (*Roy*). Essex! Cambs! Warwicks! and in the plankton of Bracebridge Pool, Sutton Park! Worcester! Surrey! Kent! Hants! (*Roy*). Devon! (*Harris*). Cornwall!

WALES.—Snowdon!, Capel Curig! (*Cooke & Wills*), and Llyn Ogwen!, Carnarvonshire. Llyn Coron, Anglesea! Ffestiniog, Merioneth!

SCOTLAND.—General! (*Roy & Biss.*). Near House of Hill, Wigtown! Orkneys and Shetlands!

IRELAND.—Donegal! Clare Isle, Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*). Down! Londonderry!

Geogr. Distribution.—France. Germany. Switzerland. Galicia in Austria. Portugal. Norway. Japan.

St. inflexum is a much commoner species than its ally *St.*

* Amongst the papers of the late Professor West is a drawing of a zygospore by the late Dr. Lütkemüller, who suggests that it is possibly *St. brachycerum*. From a study of the empty semicells surrounding the zygospore, however, the writer is inclined to attribute it to *St. inflexum* Bréb. It was of the form described above (see Pl. CLXVII, f. 7).

brachycerum. It is readily distinguished from the latter species by its longer and more slender processes, which are not so strongly incurved. The "body" of the cell is also relatively smaller, and not as broad in proportion with the length of cell.

115. **Staurastrum crenulatum** (Näg.) Delp.

(Pl. CXLIII, figs. 9–13.)

Phycastrum (Stenactinium) crenulatum Näg. Gatt. einz. Algen, 1849, p. 129, t. 8 B, a.

Staurastrum crenulatum Delp. Spec. Desm. subalp. 1877, p. 164, t. 12, f. 1–11; Wolle, Desm. U. S. 1884, p. 126, t. 42, f. 26–29; Schmidle, Beitr. Alp. Alg. 1895, p. 36; G. S. West, Variation Desm. 1899, p. 393, t. 11, f. 21–27; Börg. Alg. Faeroes, 1901, p. 234, t. 7, f. 16; Cushman in Bull. Torr. Bot. Club, 30, 1903, p. 564; Teodor. Matér. flor. alg. Rouman. 1907, p. 185.

Cells small, about as long as broad, sometimes a little longer or shorter according to the relative length of the processes, constriction deep, sinus acute, nearly rectangular, often minutely acuminate at the apex; semicells broadly oval or subfusiform, apex broad, truncate or slightly convex, and often somewhat elevated, sometimes with a pair of verrucæ; ventral margin very tumid; semicells gradually attenuated to form horizontal processes of varying length, with more or less denticulate undulate margins, denticulations near the apex of the semicell often tending to become emarginate. Vertical view 3–5-angular, sides concave, with a pair of emarginate verrucæ just within the margin; angles produced to form denticulate processes.

Zygospore unknown.

Length 20–25 μ; breadth, including the processes, 20–33 μ; breadth of isthmus 5–7 μ.

England.—Roundhay Park, Leeds, and Cautley Spout, W. Yorks! Pilmoor and Stokeley, N. Yorks! Dernford Fen, Cambs! Burnham Beeches, Bucks! Near Goring, Oxford! Warwicks! and in the plankton of Bracebridge Pool, Sutton Park! Worcester! (*Griffiths*). Uxbridge, Middlesex! Thursley Common, Surrey!

Wales.—Capel Curig, Carnarvonshire (*Roy*).

Scotland.—Pretty common (*Roy & Biss.*). Orkneys!

Ireland.—Dublin and Wicklow (*Arch.*). Lough Derryadd, Armagh! Skady and Ram's Islands, Lough Neagh!

Geogr. Distribution.—Germany. Roumania. Italy. Sicily. Norway. Sweden. Finland. Faeroes. Japan. E. Africa. United States. Newfoundland.

The relative length of the processes seems to be very variable in this species, and there also seems to be considerable variation in the strength of the granulation. After carefully studying specimens from Yorkshire, Prof. G. S. West decided that the relatively broader individuals with longer processes are usually more strongly developed as regards the spines, whilst specimens with short processes have their emarginate warts very much reduced (see 'Variation Desm.' 1899, p. 393). Some specimens have much in common with *St. margaritaceum* var. *ornatum* Boldt.

116. **Staurastrum neglectum** G. S. West.

(Pl. CXLII, figs. 16–18.)

St. tricorne var. β Ralfs, Brit. Desm. 1848, p. 134, t. 34, f. 8, b, c, and d; Cooke, Brit. Desm. 1887, p. 168, t. 64, f. 5.
St. hexacerum var. β Wittr. Gotl. Öl. sötv. Alg. 1872, p. 52; Roy & Biss. Scott. Desm. 1893, p. 21; West & G. S. West, Alg. S. England, 1897, p. 495.
St. neglectum G. S. West, Alg. Yan Yean, 1909, p. 70, t. 3, f. 12.

Cells small, $1\frac{1}{4}$–$1\frac{1}{2}$ times broader than long, including the processes; constriction extremely small, scarcely visible; lower part of semicell shortly cylindrical, upper part incudiform, apex of semicell convex, angles produced to form attenuated processes, provided with minute granules arranged in horizontal series. Vertical view triangular, "body" small, sides concave, angles produced into fairly long, attenuated, straight, or slightly curved processes, which are provided with 6 or 7 rows of minute denticulations; processes somewhat dilated towards their apex, which is tipped with 3 minute spines. Cells usually twisted, the processes of one semicell alternating with those of the other.

Zygospore spherical, with slender processes 2 or 3 times forked at the apex, and with slightly inflated bases.

Length 23·5–26 μ ; breadth, with processes, 32–35 μ ; breadth of median part of cell 6·5–7 μ ; diam. zygosp., without processes, 20–22·5 μ ; length of processes about 20 μ.

ENGLAND.—Sussex (*Ralfs*). Halgavor Moor and Kynance Valley, Cornwall ! (*Ralfs*). Rare, but widely distributed in British Isles !

Geogr. Distribution.—Sweden. United States. Australia.

This species differs from *St. hexacerum* (Ehr.) Wittr. (= *St. tricorne* Ralfs) in the smaller "body" of the semicells, the cylindrical median part of the cells, with the faintest indication of a constriction, and in the more elongate processes. The latter are also much more elegant, and are dilated towards the extremities. The appendages of the zygospores of *St. neglectum* are also more complicated than those of *St. hexacerum*.

117. **Staurastrum dubium** West.

(Pl. CXLVI, fig. 4.)

Staurastrum dubium West, Alg. N. Wales, 1890, p. 19, f. 28 ; Cushman in Bull. Torr. Bot. Club, 1904, p. 583 ; *ibid.*, 1907, p. 614.

Cells rather over medium size, nearly twice as broad as long, including the processes, deeply constricted ; semicells fusiform, rough with rather flattened granules, base of semicell with a ring of granules ; processes inflexed, with tricuspid apices ; vertical view triangular, lateral margins concave, with a row of granules just within the margin ; centre of apex smooth.

Zygospore unknown.

Length 40 μ ; breadth 70 μ ; breadth of isthmus 13 μ.

WALES.—Capel Curig, Carnarvonshire !

Geogr. Distribution.—United States.

118. **Staurastrum boreale** W. & G. S. West.

(Pl. CXLVI, fig. 5.)

Staurastrum boreale West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 27, t. 2, f. 25.

Cells small, about $1\frac{1}{2}$ times broader than long, including the processes, constriction fairly deep ; semicells

somewhat cup-shaped, upper angles produced to form long, nearly horizontal or slightly diverging processes, each provided with 4 series of denticulations, and with 3 spines at the extremity; apex of semicell very slightly produced, nearly straight and with acute emarginate granules; base of semicell with a circle of 11–13 denticulations, of which 6 or 7 may be seen in the front view. Vertical view triangular, sides nearly straight, with 3 emarginate verrucæ along each, and with 3 others just within each lateral margin.

Zygospore unknown.

Length 27–29 μ; breadth, with processes, 43–46 μ; breadth of isthmus 7·5–8 μ.

SCOTLAND.—Plankton of Loch Asta, Shetlands!

This species has only been recorded from one locality, where it occurred in considerable abundance. It is not very closely allied to any other British species, and should be compared with *St. Burmense* Turn. and *St. galeatum* Turn. (*vide* W. & G. S. West, 'Freshw. Alg. Ceylon,' 1902, p. 190, t. 22, f. 19).

119. **Staurastrum Pseudosebaldi** Wille.

(Pl. CLXVI, fig. 4.)

Staurastrum Pseudosebaldi Wille, Norges Ferskv. Alg. 1880, p. 45, t. 2, f. 30; Wolle, Desm. U. S. 1884, p. 139, t. 46, f. 8, 9; De Toni, Syll. Alg. 1889, p. 1178; Borge, Süssw. Chlor. Archang. 1894, p. 38; W. & G. S. West, Alg. S. England, 1897, p. 496; Börg. Alg. Faeroes, 1901, p. 235, t. 7, f. 17; West & G. S. West, Alga-fl. Yorks. 1902, p. 106; Cushman in Rhodora, 1903, p. 224.

Cells of medium size, about $1\frac{1}{5}$ times broader than long, including the processes; body of cell slightly constricted, sinus an acute notch; semicells cuneate, slightly campanulate at the base, widening towards the apex, lateral margins concave; upper angles produced into stout horizontal processes, each tipped with three spines, and rough with several concentric series of granules; apex of semicell with a row of regular bifid spines; base of semicell with a series of distant granules of which 3 are visible. Vertical view triangular, lateral margins

concave, with a series of projecting emarginate spines, and a further row of spines just within the margin; angles produced into granulate processes.

Zygospore unknown.

Length about 51 μ; breadth, including processes, about 60 μ; breadth of isthmus 12 μ.

ENGLAND.—Pilmoor, N. Yorks! Thursley Common, Surrey!

Geogr. Distribution.— Germany (var.). Galicia in Austria. Norway. Poland. N. Russia. Faeroes. Greenland. Siberia (var.). India. New Zealand (var.). United States.

St. Pseudosebaldi differs from *St. Manfeldtii* in the distant granules at the base of the semicell, and in the spiny lateral margins in the end view. From *St. Sebaldi* var. *ornatum* it is distinguished by its shorter processes and the bifid spines which project from the lateral margins in the end view.

Var. **simplicius** West. (Pl. CXLIX, fig. 13.)

St. Pseudosebaldi var. *simplicius* West, Alg. Engl. Lake Distr. 1892, p. 21, t. 9, f. 37.

Cells smaller than in the type, with the apical spines simple instead of emarginate; processes shorter, tipped with 3 spines longer than usual.

Length, with spines, 32 μ; breadth 46 μ; breadth of isthmus 9 μ.

ENGLAND.—Brandreth, Westmoreland!

120. **Staurastrum Manfeldtii** Delp.

(Pl. CXLVIII, fig. 2.)

Staurastrum Manfeldtii Delp. Spec. Desm. subalp. 1877, p. 160, t. 13, f. 6–19; De Toni, Syll. Alg. 1889, p. 1214; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 108; Lütkem. Desm. Central China, 1900, p. 123; Comère, Desm. de France, 1901, p. 158, t. 11, f. 8; West & G. S. West, Alg. N. Ireland, 1902, p. 56; Freshw. Alg. Orkneys & Shetlands, 1905, p. 27; Brit. Freshw. Phytoplankton, 1909, p. 175; Hustedt, Desm. et Bacill. Tirol. 1911, p. 339.

Cells of medium size, about $1\frac{1}{3}$ times broader than long, including the processes; constriction small; semi-

cells subcuneate or cup-shaped, broadening towards the apex, which is slightly convex and provided with a row of emarginate or irregular verrucæ; upper angles produced to form tapering processes tipped with 3 minute spines, and covered with several series of denticulations which are sometimes continued over the body of the semicell itself, processes slightly converging or nearly horizontal. Vertical view usually triangular, sides straight, or very slightly convex, angles produced to form processes with slightly undulating margins, with a series of emarginate verrucæ just within each lateral margin.

Zygospore unknown.

Length 42–57 μ; breadth, including processes, 55–100·8 μ; breadth of isthmus 9–13 μ.

England.—Plankton of Ennerdale Water, Cumberland! and Malham Tarn, W. Yorks! Plankton of Bracebridge Pool, and Windmill Pool, Shirley, Warwickshire!

Scotland.—Plankton of Lochs Sandy, Trebister, Beosetter and Bressay, Shetlands!

Ireland.—Near Lough Magrath, Donegal! Plankton of Lough Accorymore, Achill Isle, Mayo! Ballynahinch, Galway!

Geogr. Distribution.—France. Galicia and Austria. Italy. Norway. Siberia. Central China. India. Australia.

In the originally described Italian specimens the apical verrucæ were very much more irregular in size and form than in the British examples, and near the origin of each process there was a longer conspicuous spinous verruca. In the British specimens the verrucæ are all more or less of the same size, and form quite a regular series. There is a further difference in the British examples in the presence of delicate granules, either in scattered groups, or forming a circular band round the base of the semicell. The species is not infrequent in plankton gatherings.

Var. **annulatum** W. & G. S. West. (Pl. CXLVIII, fig. 3.)

St. Manfeldtii var. *annulatum* West & G. S. West, Alg. N. Ireland, 1902, p. 56, t. 1, f. 30, 31.

Processes slightly narrower than in the type; apical

verrucæ somewhat reduced; with a double series of granules round the base of the semicell.

Length 46–49 μ; breadth, including processes, 63–70 μ; breadth of isthmus 10·5 μ.

IRELAND.—Near Lough Magrath, Donegal!

The double ring of granules round the base of the semicells and the slight reduction of the apical emarginate warts are characters which at once distinguish this variety. It bears a certain resemblance to *St. Pseudosebaldi* Wille, but the body of the plant is relatively larger, and the granulation is different. In the vertical view the sides are quite smooth, all the verrucations being within the margin as in typical *St. Manfeldtii.*

121. **Staurastrum Duacense** W. & G. S. West.

(Pl. CXLVIII, fig. 1.)

Staurastrum Pseudosebaldi subsp. *duacense* West, Alg. W. Ireland, 1892, p. 184, t. 24, f. 1.
St. bicorne ? Borge, Sverig. Chlor. II, 1895, p. 24, f. 15.
St. Duacense W. & G. S. West, Brit. Freshw. Phytoplankt. 1909, p. 202.

Cells of medium size, nearly twice as broad as long, including the processes, constriction fairly deep, sinus acute; semicells cuneate, broadening towards the apex, not inflated at the base, but sometimes with a minute granule on each lateral margin near the sinus; apex broad and straight, with a row of emarginate verrucæ; angles produced to form long, horizontal processes, bifid at their extremity; dorsal margin of processes verrucose, verrucæ reduced to simple denticulations towards the tips; ventral margin of processes similarly ornamented. Vertical view oval, the poles produced to form long processes tipped with a spine, margins smooth, with a series of emarginate verrucæ just within. Chloroplast axile with a central pyrenoid and 5 or 6 ridges.

Zygospore unknown.

Length 32–38 μ; breadth, including processes, 55–67 μ; breadth of isthmus 9–11 μ; greatest thickness 18 μ.

IRELAND.—Ballynahinch and Roundstone, Galway!

Geogr. Distribution.—Scandinavia.

This species is only known in the British Isles from one locality in western Ireland, and is apparently one of those species which can only flourish in waters draining from the older and harder palæozoic rocks. It is very similar in appearance to *St. Pseudosebaldi* Wille var. *bicorne* Boldt ('Sibir. Chloroph.' 1885, t. 6, f. 36), but differs in the more complicated lateral margins of the semicells.

It also differs from *St. Pseudosebaldi* var. *tonsum* Nordst. ('Freshw. Alg. New Zealand,' 1888, p. 36, t. 4, f. 4) in the non-fusiform shape of the end view as well as in its stronger apical warts. *St. bicorne* Hautpfl. ? forma Borge ('Sverig. Chloroph.' II, 1895, p. 24, t. 1, f. 15) is a form of *St. Duacense*, differing only in its rather larger size and in the apical teeth of the processes.

122. **Staurastrum bicorne** Hauptfl.

(Pl. CXLIII, fig. 17.)

St. bicorne Hauptfl. Zellmembr. u. Hüllgallerte Desm. 1888, p. 37, t. 3, f. 21, 24, 27; Börg. Bornholm. Desm.-fl. 1889, p. 148, t. 6, f. 9; De Toni, Syll. Alg. 1889, p. 1210; Roy & Biss. Scott. Desm. 1893, p. 17; Hirn, Desm. Finnl. 1903, p. 19; Cedergren, Sverig. sötvattensalg. 1913, p. 23.

Cells of medium size, about $1\frac{1}{3}$ times broader than long, including the processes, sinus becoming very wide towards the exterior; semicells subtriangular, rapidly widening towards the apex, sides concave, apex very slightly convex, angles of semicell gradually attenuated to form fairly long, stout, and nearly horizontal processes, which are provided with several series of denticulations, and are bifid (?) at their apex; upper margin of face with two transverse series of about 5–8 verrucæ. Vertical view narrowly fusiform, lateral margins verrucose in the middle and with another series of verrucæ just within each margin; processes with denticulations.

Zygospore unknown.

Length $52\,\mu$; breadth, including processes, $72\,\mu$; thickness $18{\cdot}5\,\mu$; breadth of isthmus $13{\cdot}4\,\mu$.

Scotland.—Birsemore Loch, Aberdeen (*Roy & Biss.*).

Geogr. Distribution. — Germany. Bornholm (var.). Finland. Sweden. Australia (var.).

123. **Staurastrum subgracillimum** W. & G. S. West.
(Pl. CXLIV, figs. 1, 2.)

St. subgracillimum West & G. S. West, Some N. A. Desm. 1896, p. 263, t. 17, f. 3, 4; Alg. N. Ireland, 1902, p. 56, t. 1, f. 21, 22; Alg. Ceylon, 1902, p. 186; Further Contr. Freshw. Phytopl. Scott. Lochs, 1905, p. 504; Brit. Freshw. Phytoplankton, 1909, p. 202.

Cells small, about as long as broad, excluding the processes; semicells broadly cuneate, sides straight, apex distinctly concave, upper angles produced to form very long slender processes, which are nearly horizontal, and of the same width throughout their whole length, with margins minutely undulate. Vertical view triangular or quadrangular, sides straight or very slightly concave, angles produced to form long processes, the apices of which are furnished with 3 spreading teeth; processes denticulate, cell-wall otherwise smooth. Cells often twisted at the isthmus.

Zygospore unknown.

Length 10·5–15·5 μ; breadth, without processes, 10–13 μ; with processes, 40–60 μ; breadth of isthmus 4·8–6 μ.

Scotland.—Rhiconich, Sutherland! Plankton of small loch near Cearnabhal, Lewis, Outer Hebrides!

Ireland.—Near Glenties, Co. Donegal!

Geogr. Distribution.—Ceylon. United States.

The distinctive features of this species are the concave apex, and the long slender parallel processes. In the British Isles it is a very rare Desmid, and is confined to bogs and lakes of the "western" area.* The British examples all differ from the original American specimens in their rather more robust processes, and in their very minute apical spines. Both the American and Ceylon specimens were provided with three larger spreading teeth, all lying in the same horizontal plane.

124. **Staurastrum tetracerum** Ralfs.
(Pl. CXLIX, figs. 2, 3.)

? *Micrasterias tetracera* Kütz. Syn. Diat. 1834, p. 74, t. 7, f. 83, 84.
Binatella tetracera Bréb. Alg. Falaise, 1835, p. 269.

* See p. 18.

Staurastrum paradoxum Ehr. Inf. 1838, p. 143, t. 10, f. 14.
St. tetracerum Ralfs, in Ann. Mag. Nat. Hist. 1845, v. 15, p. 150, t. 10, f. 1; Brit. Desm. 1848, p. 137, t. 23, f. 7; De Bary, Conj. 1858, p. 71; Arch. in Pritch. Infus. 1861, p. 744; Rabenh. Krypt.-fl. Sachs. 1863, p. 191; Lund. Desm. Suec. 1871, p. 68; Nordst. Norges Desm. 1873, p. 35; Delp. Spec. Desm. subalp. 1877, p. 161, t. 11, f. 25–28; Kirchn. Alg. Schles. 1878, p. 168; Cooke, Brit. Desm. 1887, p. 182, t. 63, f. 5; De Toni, Syll. Alg. 1889, p. 1232; West, Alg. W. Ireland, 1892, p. 187; Alg. Engl. Lake Distr. 1892, p. 21; Roy & Biss. Scott. Desm. 1893. p. 26; West & G. S. West, Alg. Madag. 1895, p. 80; Alg. S. England, 1897, p. 495; Lütkem. Desm. C. China, 1900, p. 124; Comère, Desm. de France, 1901. p. 160, t. 11, f. 7; West & G. S. West, Alga-fl. Yorks. 1902, p. 104; Freshw. Alg. Orkneys & Shetlands, 1905, p. 25; Alg. Third Tanganyika Expedit. 1907, p. 127; Kaiser, Alg. Traun. u. Chiem. 1914, p. 153.
Phycastrum paradoxum Kütz. Spec. Alg. 1849, p. 180 (in part).
Staurastrum paradoxum var. *tetracerum* Rabenh. Flor. Europ. Alg. 1868, p. 210.
St. Arachne var. *tetracerum* Jacobs. Desm. Danemark, 1875, p. 208.
St. tetracerum var. *undulatum* West & G. S. West, Alg. Madag. 1895, p. 80, t. 9, f. 6.
St. gracillimum var. *biradiatum* Bohlin, Flor. Algol. d'eau douce d'Açores, 1901, p. 55, t. 1, f. 12.

Cells minute, about as long as broad, or up to $1\frac{1}{5}$ times longer than broad, including the processes; constriction fairly deep, sinus open with a minutely excavated apex; semicells short and rectangular, apex straight or slightly concave, upper angles produced to form long, strongly diverging processes, gradually attenuated towards their apices, and with 4 or 5 undulations; apex of processes minutely emarginate. Vertical view fusiform with the poles drawn out to form nodulose processes. Cells often twisted at the isthmus.

Zygospore globose, with about 16 long processes swollen at the base, and once or twice dichotomous at the apex (Lund.).

Length, without processes, 7–10 μ; with processes, 24–28 μ; breadth, including processes, 18–30 μ; breadth of isthmus 4–5 μ; diam. zygosp., without processes, 16 μ; with processes, 30 μ.

England.—Cumberland! Westmoreland! Lancashire! W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Norfolk! Warwicks! Worcester! Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Kent! Hants! (*Roy*). Wilts! Devon! Cornwall!

Wales.—General (often abundant)! In the plankton!

Scotland.—General! (*Roy & Biss.*). Not uncommon in the plankton! Orkneys! In the plankton, Shetlands!

Ireland.—Donegal! Mayo and Clare Isle! Galway! Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Turkey. Norway. Sweden. Denmark. Bornholm. Central and S. Russia. Faeroes. Iceland. Greenland. Siberia. Central China. Japan. Ceylon. Burma. Australia. Madagascar. Central Africa. Abyssinia. Azores. United States. Guiana. Colombia. Brazil. Patagonia.

Forma **trigona** Lund. (Pl. CXLIX, fig. 4.)

St. tetracerum forma *trigona* Lund. Desm. Suec. 1871, p. 69; West, Alg. W. Ireland, 1892, p. 187; West & G. S. West, Alg. S. England, 1897, p. 495; Alg. Orkneys & Shetlands, 1905, p. 25.

Cells in end view triradiate.

Dimensions as in the biradiate form.

England.—Lancashire! Burnham Beeches, Bucks! Surrey! Hants! Devon! Cornwall!

Wales.—Llyn Idwal and Moelfre, Carnarvonshire!

Scotland.—Rhiconich, Sutherland! Bressay, Shetlands!

Ireland.—Mayo and Clare Isle! Galway! Kerry!

Geogr. Distribution.—Sweden.

Forma **tetragona** W. & G. S. West.

St. tetracerum forma *tetragona* West & G. S. West, Alg. S. England, 1897, p. 495.

Cells in end view 4-radiate.

England.—Roughton Moor, Cornwall!

Staurastrum tetracerum is a very characteristic and easily recognised species with a world-wide distribution. The biradiate form is the commonest; the 3- and 4-radiate forms are comparatively rare.

Bohlin ('Flor. Algol. d'eau douce d'Açores,' 1901, p. 56, f. 12) has described and figured a rather large form of this species under the name of *St. gracillimum* var. *biradiatum*. The same author has also figured (fig. 13) a specimen intermediate in form

between this species and *St. bibrachiatum* Reinsch var. *cymatium* West (= *Dichotomum bibrachiatum* W. & G. S. West var. *cymatium*). A reduced form of the latter species has also been described and figured by West & G. S. West ('Alg. Madag.' 1895, p. 74, t. 8, f. 28 a′ and b′). Bohlin criticises the creation of the new genus *Dichotomum* in view of the discovery of such forms as these, which obviously link it up with *Staurastrum*. It must be pointed out, however, that practically all divisions between allied genera are more or less arbitrary, and that as a rule no hard and fast line can be drawn between them. This is particularly true in the case of the Desmidiaceæ, and species forming links between other genera of the group have already been noted in this work (see vol. ii, p. 126; vol. iv, p. 89). Nevertheless no one would desire, for example, that the genus *Arthrodesmus* be abolished because it is closely linked up with some forms of *Staurastrum*. In the same way it will probably be very convenient to retain the genus *Dichotomum* also, although it is very closely allied to *Staurastrum*.

Var. **validum** W. & G. S. West. (Pl. CXLIX, fig. 5.)

St. tetracerum var. *validum* West & G. S. West, Alg. S. England, 1897, p. 495, t. 6, f. 25.

A rather larger form, with the body of the cell relatively longer; processes stouter and not at all attenuated, with 5 undulations.

Length, without processes, 18 μ; with processes, 42 μ; breadth, without processes, 13 μ; with processes, 37 μ; breadth of isthmus 5 μ.

England.—Near Chapel Wood, Surrey!

125. **Staurastrum iotanum** Wolle. (Pl. CXLIX, fig. 1.)

Staurastrum iotanum Wolle, Desm. U. S. 1884, p. 137, t. 51, f. 5–7; De Toni, Syll. Alg. 1889, p. 1147; West, Alg. N. Wales, 1890, p. 20; Roy & Biss. Scott. Desm. 1893, p. 21; Turn. Alg. E. India, 1893, p. 132, t. 22, f. 12; West & G. S. West, Alg. S. England, 1897, p. 495; Desm. U. S. 1898, p. 314, t. 18, f. 14, 15; Alg. Ceylon, 1902, p. 185.

Cells very minute and inconspicuous, slightly broader than long, including the processes, constriction fairly deep, sinus small, acute-angled and open; semicells

subrectangular, lower angles not rounded, practically rectangular, apex very slightly convex, upper angles produced to form long diverging processes, with 2 or 3 undulations and emarginate apices; vertical view triangular, sides nearly straight, angles produced into long nodulose processes; cell-wall smooth.

Zygospore unknown.

Length, without processes, 8–10 μ; including processes, 13–20 μ; breadth, without processes, 6–9 μ; including processes, 13–21 μ; breadth of isthmus 3·5–4 μ.

ENGLAND.—Puttenham Common, Surrey!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Near Girnoc, Aberdeen (*Roy & Biss.*). Spital of Glen Shee, Perth! Rhiconich, Sutherland!

Geogr. Distribution.—Sweden (var.). Poland. Ceylon. United States.

126. **Staurastrum pseudotetracerum** (Nordst.) W. & G. S. West.

(Pl. CXLIX, fig. 11.)

Staurastrum contortum var. *pseudotetracerum* Nordst. in Botan. Notiser, 1887, p. 157; Freshw. Alg. New Zeal. 1888, p. 37, t. 4, f. 9; De Toni, Syll. Alg. 1889, p. 1231; West, Alg. W. Ireland, 1892, p. 183.

St. pseudotetracerum West & G. S. West, Alg. Madag. 1895, p. 79, t. 8, f. 39; Desm. U. S. 1898, p. 314; Bohlin, Flor. Alg. d'eau douce d'Açores, 1901, p. 58, t. 1, f. 16; West & G. S. West, Alga-fl. Yorks. 1902, p. 104; Alg. Ceylon, 1902, p. 185.

Cells very small, about as long as broad, including the processes, deeply constricted, sinus widely open, broadly triangular in outline; semicells cuneate, apex nearly straight, or slightly convex or concave, upper angles produced to form short, strongly diverging processes tipped with 3 very minute spines; processes rough with subacute granules arranged in concentric series. Vertical view triangular or quadrangular, sides concave, angles produced to form granulose processes.

Zygospore unknown.

Length, without processes, 12–19 μ; with processes,

19–25 μ ; breadth, including processes, 19–30 μ ; breadth of isthmus 5–6 μ.

England.—Skipwith Common, N. Yorks !

Scotland.—Benbecula, Outer Hebrides !

Ireland.—Lakes, near Recess, Galway !

Geogr. Distribution.—Sweden (var.). Ceylon. Siam (var.). New Zealand. Madagascar. Azores. United States.

This little species is readily distinguished from *St. tetracerum* by the relatively larger body of the semicell, and its stouter habit. From *St. micron* West it is distinguished by its cuneate semicells, and its more slender processes with several series of granules.

127. **Staurastrum micron** West.

(Pl. CXLIX, fig. 6.)

Staurastrum micron West & G. S. West, New and Int. Freshw. Alg. 1896, p. 159, t. 4, f. 50, 51 ; Alg. S. England, 1897, p. 495 ; Freshw. Chlorophy. Koh Chang, 1901, p. 95 ; Alg. N. Ireland, 1902, p. 57.

Cells very small, about as long as broad, including the processes, deeply constricted ; semicells inversely semicircular, apex slightly convex ; upper angles produced to form short, stout, diverging processes, each process with two series of short spines near its base, and dilated at its apex, which is truncate and provided with 3 short spines. Vertical view triangular, sides concave, angles produced to form short dilated processes.

Zygospore unknown.

Length, without processes, 8·5–11·5 μ ; with processes, 12–17·5 μ ; breadth, without processes, 7–9·5 μ ; with processes, 12·5–19 μ ; breadth of isthmus 3–3·5 μ.

England.—Puttenham Common, Surrey (abundant) ! Woodbury Common, Devon !

Ireland.—Near Glenties, and Lough Gartan, Donegal !

Geogr. Distribution.—Sweden (var.). Siam (form). W. Africa (var.).

This tiny species has very constant characters which render

it easy of distinction. It is nearest to *St. pseudotetracerum* West, but is much smaller, its processes are shorter and more robust, and the spines at the dilated apices of the processes and two rings of short spines at their base distinguish it.

128. **Staurastrum latiusculum** W. & G. S. West.

(Pl. CXLIX, fig. 8.)

Staurastrum latiusculum West & G. S. West, Alg. N. Ireland, 1902, p. 53, t. 1, f. 20.

Cells small, about $1\frac{1}{3}$ times broader than long, including the processes, constriction fairly deep, sinus open, broadly semi-elliptical; semicells inversely trapeziform, apex slightly convex, lower angles rectangular, upper angles produced to form fairly long, distinctly diverging processes, each with three denticulate undulations and tipped with 3 minute spines. Vertical view quadrangular, sides slightly concave, angles produced to form long denticulate processes, with a conspicuous small spine on each side at the base of each process.

Zygospore unknown.

Length, without processes, 13 μ; with processes, 19–23 μ; breadth, without processes, about 13–13·5 μ; with processes, 32 μ; breadth of isthmus 9 μ.

Ireland.—Near Glenties, Co. Donegal!

The distinctive characters of this species are its small size, its relatively broad body with a small semi-elliptical sinus, and the paired spines at the base of each process.

129. **Staurastrum pelagicum** W. & G. S. West.

(Pl. CXLVI, fig. 6.)

Staurastrum pelagicum West & G. S. West, Freshw. Alg. N. Ireland, 1902, p. 46, t. 2, f. 26, 27; Comp. Study Plank. Irish Lakes, 1906, p. 86; Ostenf. & Wes.-Lund, Fortnightly Explor. Plankton Icelandic Lakes, 1906, p. 1111; Borge in Botan. Notiser, 1913, p. 49.

Cells of medium size, $1\frac{1}{5}$ times broader than long, without the processes, deeply constricted, sinus open, but becoming very narrow towards its apex; semicells

oblong-elliptic, the ventral margin more convex than the dorsal, angles produced to form short, stout, diverging processes, externally smooth, and quite solid, with deeply bifurcated apices. Vertical view triangular, sides slightly concave, angles produced to form short solid processes, bifurcate at the apex. Cell-wall covered with granules arranged in about 4 distant series round the angles, minutely punctate between the granules.

Zygospore unknown.

Length, without spines, 34–40 μ; breadth, without spines, 38–47 μ; with spines, 64–75 μ; breadth of isthmus 12·5–13 μ.

SCOTLAND.—Plankton of the Orkneys and Shetlands!

IRELAND.—Plankton of Lough Corrib, Galway! Lough Neagh! Lough Beg, Londonderry!

Geogr. Distribution.—Sweden (form). Iceland (form).

This species, which only occurs in plankton, is perhaps nearest to *St. Avicula* Bréb. It differs from that species, however, in its much larger size and in the peculiar, solid, deeply bifurcate processes, which are directed slightly upwards. The two spines of *St. Avicula* are attached more or less independently to the body of the *Staurastrum*, whereas the much larger spines of *St. pelagicum* are the two divisions of a very deeply divided but solid process. It is also closely allied to *St. pseudopelagicum* W. & G. S. West, but is distinguished by its more elliptical semicells and solid processes. The processes of *St. pseudopelagicum* are hollow, but the terminating spines of the two species are very similar.

130. **Staurastrum polymorphum** Bréb.

(Pl. CXLII, fig. 24; Pl. CXLIII, figs. 1–3.)

St. polymorphum Bréb. in Ralfs, Brit. Desm. 1848, p. 135, t. 22, f. 9, t. 34, f. 6; Arch. in Pritch. Infus. 1861, p. 742, t. 2, f. 20, 21, 24, 25, 31; Rabenh. Krypt.-fl. Sachs. 1863, p. 192; De Not. Desm. Ital. 1867, p. 52, t. 4, f. 46; Rabenh. Flor. Europ. Alg. 1868, p. 209; Delp. Spec. Desm. subalp. 1877, p. 162, t. 11, f. 56–62; Kirchn. Alg. Schles. 1878, p. 167; Wille, Ferksv. Alg. Nov. Semlj, 1879, p. 53; Wolle, Desm. U. S. 1884, p. 126, t. 42, f. 9, 10, 24, 25; Cooke, Brit. Desm. 1887, p. 169, t. 58, f. 4; Boldt, Desm. Grönland, 1888, p. 38; Hansg. Prodr. Alg. Böhm. 1888, p. 213; De Toni, Syll. Alg. 1889, p. 1208; Anderss. Sverig. Chlor. 1890, p. 12; Gütw. Flor. Glonów Okolic Lwowa, 1891, p. 68; Flor. Glonów Galic.

1892, p. 30; West, Alg. W. Ireland, 1892, p. 181; Roy & Biss. Scott. Desm. 1893, p. 23; Lütkem. Desm. Attersees, 1893, p. 567; W. & G. S. West, Alg. S. England, 1897, p. 495; Borge, Süsswasseralgen Franz Josefs Land, 1899, p. 763; Comère, Desm. de France, 1901, p. 157, t. 13, f. 13; West & G. S. West, Alga-fl. Yorks. 1902, p. 105; Freshw. Alg. Orkneys and Shetlands, 1905, p. 26; Gutw. Flor. Alg. Mont. Tatrensium, 1909, p. 475; Georgev., Desm. Macedon. 1910, p. 244; Hustedt, Desm. Tirol, 1911, p. 340.

Didymidium (Staurastrum) polymorphum Reinsch, Algenfl. Frank. 1867, p. 165 (in part).

Cells small, about $1\frac{1}{4}$ times broader than long, including the processes, constriction moderately deep, sinus acute and almost rectangular, sometimes minutely acuminate at its apex; semicells variable in form, subelliptical, subfusiform or even subcuneate, ventral margin usually more strongly convex than the dorsal; semicells attenuated at the angles to form short stout processes, horizontal or very slightly incurved, tipped with 3 or 4 minute spines and provided with 3 or 4 series of minute denticulations; "body" of semicell also granulate, granules arranged in concentric series round the angles. Vertical view usually 3- (–7-) angular, the two semicells of the same individual often differing in the number of processes, lateral margins very slightly concave; centre of apex smooth. Chloroplast axile, with a central pyrenoid in each semicell, and a pair of lobes extending into each angle.

Zygospore spherical or somewhat angular, with stout processes, branched at the apex.

Length 21–29 μ; breadth, including processes, 21–43 μ; breadth of isthmus 6–8 μ; diam. zygosp., without processes, 30 μ; including processes, 55 μ.

ENGLAND.—Cumberland! and in the plankton of Ennerdale Water! Westmoreland (*Bissett*)! Lancashire (*Roy*). W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Warwicks (*Wills*)!, and in the plankton of Bracebridge Pool, Sutton Park! Worcester (*Griffiths*)! Surrey! Sussex (*Ralfs*). Hants (*Bennett*)! Dartmoor, Devon (*Harris*). Cornwall! (*Marquand*).

WALES.—Bethesda, Llyn Idwal, Snowdon, Capel Curig, Llyn Bochlwyd, Moel Siabod, and Llyn-y-cwm-

ffynon, Carnarvonshire! Ffestiniog! and Dolgelly (*Ralfs*), Merioneth.

SCOTLAND.—General and variable (*Roy & Biss.*). Ross! Inverness! Aberdeen! Perth! Argyle! Lewis and Harris, Outer Hebrides! Orkneys and Shetlands! Rare in the plankton!

IRELAND.—Donegal! Mayo and Clare Isle! Galway! Kerry! Dublin and Wicklow (*Arch.*). Armagh!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Servia. Macedonia. Norway. Finmark. Sweden. Denmark. Finland. Poland. N. and S. Russia. Russian Lapland. Faeroes. Nova Zembla. Franz Josef's Land. Spitzbergen. Greenland. Siberia. Mongolia. Japan. Ceylon. Central Africa. United States and Alaska. Canada. West Indies. Patagonia.

This small and very variable species has an almost world-wide distribution.

Var. **pusillum** West. (Pl. CXLIII, fig. 4.)

St. polymorphum var. *pusillum* West, Clare Isl. Alg. 1912, p. 23.

Cells much smaller, processes thinner and slightly inflexed; "body" of semicell similar in form to the type.

Length 18–18·5 μ.

IRELAND.—Clare Isle, Mayo!

Var. **subgracile** Wittr.

St. polymorphum var. *subgracile* Wittr. Gotl. Öl. sötv. Alg. 1872, p. 51; De Toni, Syll. Alg. 1889, p. 1209; West, Alg. W. Ireland, 1892, p. 181; Lütkem. Desm. Attersees, 1893, p. 567; Kaiser, Algenfl. Traunstein u. Chiemgau, I, 1914, p. 153.

Processes longer than in the type, semicells in vertical view triangular, angles produced, lateral margins concave.

Length 22·5–28 μ; breadth, including processes, 30–45 μ; length of processes, 6–12 μ; breadth of isthmus 8–9 μ.

Ireland.—Derryclare Lough and lakes E. of Lough Bofin, Co. Galway!

Geogr. Distribution.—Austria. Bornholm. Scandinavia. Siberia.

Figures of this variety have never been published, but Wittrock, in describing it, says that it is very similar to t. 22, f. 9 g, in Ralfs, 'Brit. Desm.' and t. 8 B, f. n, o, p in 'Näg. Gatt. einz. Alg.' 1849. Its distinguishing feature seems to be that the processes are longer. It may be that this variety is merely a form of *St. crenulatum*.

Var. **simplex** W. & G. S. West. (Pl. CXLIII, fig. 5.)

St. polymorphum var. *simplex* West & G. S. West, Freshw. Alg. Orkneys & Shetlands, 1905, p. 26, f. 28.

Cells relatively longer than in the type. not including the processes; processes very slightly divergent, with one circle of denticulations, and the apex of each tipped with 4 minute spines; cell-wall otherwise quite smooth. Vertical view quadrangular.

Length, without processes, 21–23 μ; breadth, without processes, 12·5–15 μ; with processes, 23–28·5 μ; breadth of isthmus 7·6 μ.

Scotland.—Near Lerwick, Shetlands!

Var. **munitum** West. (Pl. CXLIII, fig. 6.)

St. polymorphum var. *munitum* West, Alg. Engl. Lake Distr. 1892, p. 20, f. 35; Schmidle, Lappmark Süsswasseralgen, 1898, p. 60 (forma).

Processes provided with 3 or 4 series of sharp denticulations; cells in vertical view triangular, sides straight.

Length 31 μ; breadth, with processes, 36 μ; breadth of isthmus 8 μ.

England.—Esthwaite Water, Lancashire!

Geogr. Distribution.—Sweden (form).

131. **Staurastrum affine** W. & G. S. West.

(Pl. CXLII, fig. 23.)

St. affine West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 26, t. 2, f. 27.

Cells rather under medium size, slightly longer than broad, including the processes, constriction fairly deep; semicells elliptic-subsemicircular, ventral margin strongly convex, dorsal margin slightly so, angles produced to form short thick processes, slightly divergent, terminated by 4 short spines, and with 2 or 3 circles of strong denticulations. Vertical view triangular, sides slightly convex, angles produced into short thick processes, which are distinctly denticulate. Cell-wall rough with minute granules, arranged in concentric series round the base of the processes.

Zygospore unknown.

Length, without processes, 37–40 μ; breadth, without processes, about 29–33 μ; breadth, with processes, 44–55 μ; breadth of isthmus 10·5 μ.

SCOTLAND.—Plankton of Neugles Water and Loch Brindister, Shetlands!

This species was found in abundance in the plankton of the above-mentioned lakes. Its distinctive characters are the large size of the "body" of the semicells, and the short, outwardly diverging processes, each of which possesses 2 rings of denticulations and 4 apical spines. It is perhaps nearest to *St. polymorphum* Bréb., but is larger, of different relative proportions, and with different processes.

132. **Staurastrum proboscidium** (Bréb.) Arch.

(Pl. CXLIII, figs. 14–16.)

Staurastrum asperum var. *proboscidium* Bréb. in Ralfs, Brit. Desm. 1848, p. 139, t. 23, f. 12, b, c.

St. proboscidium Arch. in Pritch. Infus. 1861, p. 742; Jacobs. Desm. Danem. 1875, p. 206; Cooke, Brit. Desm. 1887, p. 173, t. 59, f. 6; De Toni, Syll. Alg. 1889, p. 1215; Comère, Desm. de France, 1901, p. 151, t. 11, f. 10; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 28; Borge, Botan. Notiser, 1913, p. 31.

Didymidium (*Staurastrum*) *polymorphum* Reinsch, Algenfl. Frank. 1867, p. 165 (in part).

Staurastrum hexacerum v. *ornatum* Borge, Süssw. Chlor. Archang. 1894, p. 37, t. 3, f. 43 (form).

St. Borgeanum Schmidle, Lappm. Süsswasseralgen, 1898, p. 60, t. 3, f. 7; West & G. S. West, Notes Alg. II, 1900, p. 297, t. 412, f. 10; Alga-fl. Yorks. 1902, p. 106.

? *St. proboscidium* var. *subglabrum* West, Alg. N. Wales, 1890, p. 19, f. 35.

Cells of medium size, about as long as broad, including the processes, but sometimes either slightly longer or shorter than broad; deeply constricted, sinus acute, opening widely, with a minute excavation at its apex; semicells subelliptical or subcuneate, apex and lateral margins slightly convex; angles prolonged to form short stout horizontal processes, which are truncate at their apices, tipped with a circle of minute granules, and with several concentric series of granules beneath; upper part of faces of semicell with several longitudinal series of granules, the uppermost granule of each series being developed into an emarginate verruca; base of semicell with a circle of simple granules. Vertical view triangular, sometimes quadrangular; sides concave, with a series of emarginate verrucæ just within the margin; angles slightly produced into short truncate processes; centre of apex smooth.

Zygospore unknown.

Length 35–45 μ; breadth 30–53 μ; breadth of isthmus 10–11·5 μ.

ENGLAND.—Loughrigg, Westmoreland! Cam Fell, W. Yorks! Bog near Widdale Beck, N. Yorks! Epping Forest, Essex! New Forest, Hants (*Bennett*). Near Chapel Wood, Surrey! Dartmoor, Devon (*Harris*). Near St. Just, Cornwall!

WALES.—Llyn Ogwen, Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Glen Logie!, Perth, Fife, and Arran (*Roy & Biss.*). Orkneys! Shetlands!

IRELAND.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Austria (var.). Norway. Sweden. Finland. Denmark. Bornholm. Spitzbergen. Greenland. Siberia (var.). Central China (var.). Java. Central Africa. New Zealand (var.). Brazil (var.).

There seems little doubt that *St. Borgeanum* Schmidle is identical with *St. proboscidium* (Bréb.) Arch., although the figures in Ralfs, 'Brit. Desm.' are not particularly good. The British specimens are often not exactly typical, being charac-

terised by their very slightly concave or even straight margins in the end view, and somewhat shorter and more broadly truncate processes. West in 'Alg. N. Wales,' 1890, p. 90, f. 35, described a variety *subglabrum* of this species, which seemed to be almost destitute of granules. This variety has never been observed since it was first described, and the original figure of it scarcely gives a clear idea of its exact nature. Accordingly, for the present, it must be considered a doubtful form.

133. **Staurastrum margaritaceum** (Ehrenb.) Menegh.

(Pl. CL, figs. 5–9.)

Pentasterias margaritaceum Ehrenb. Infus. 1838, p. 144, t. 10, f. 15.
Staurastrum margaritaceum Menegh. Synops. Desm. 1840, p. 227; Ralfs in Ann. Mag. Nat. Hist. vol. 15, 1845, p. 157, t. 11, f. 7; Brit. Desm. 1848, p. 134, t. 21, f. 9; Bréb. Liste Desm. 1856, p. 140; Arch. in Pritch. Inf. 1861, p. 744, t. 3, f. 34, 35; De Not. Desm. Ital. 1867, p. 53, t. 5, f. 48; Rabenh. Flor. Europ. Alg. 1868, p. 206; Nordst. Norges Desm. 1873, p. 28; Desm. Arctoæ, 1875, p. 33; Kirchn. Alg. Schles. 1878, p. 166; Gay, Mono. loc. Conj. 1884, p. 68; Wolle, Desm. U. S. 1884, p. 125, t. 41, f. 31–35; Cooke, Brit. Desm. 1887, p. 181, t. 64, f. 12; Hansg. Prodr. Alg. Böhm. 1888, p. 212; De Toni, Syll. Alg. 1889, p. 1227; West, Freshw. Alg. N. Yorks. 1889, p. 6, t. 291, f. 11; Freshw. Alg. N. Wales, 1890, p. 20, t. 6, f. 22; Alg. W. Ireland, 1892, p. 186; Alg. Engl. Lake Distr. 1892, p. 21; Borge, Chlor. Norske Finmark, 1892, p. 8; Roy & Biss. Scott. Desm. 1893, p. 22; West & G. S. West, New and Int. Alg. 1896, p. 160, t. 4, f. 36; Alg. S. England, 1897, p. 496; Lütkem. Desm. Millstättersees, 1900, p. 22; Comère, Desm. de France, 1901, p. 158, t. 11, f. 18; West & G. S. West, Freshw. Chloroph. Koh Chang, 1901, p. 95; Alga-fl. Yorks. 1902, p. 108; Borge, Sao Paulo Alg. 1918, p. 50.
Phycastrum margaritaceum Kütz. Phyc. Germ. 1845, p. 138; Spec. Alg. 1849, p. 181.
Ph. (*Stenactinium*) *margaritaceum* Näg. Gatt. einz. Alg. 1849, p. 128.
Didymidium (*Staurastrum*) *margaritaceum* Reinsch, Alg. Frank. 1867, p. 162 (in part).
Staurastrum angulosum Schmidt, Grundl. Algenfl. Lüneb. Heide, 1903, p. 18, t. 1, f. 3.

Cells small, about as long as broad, or often slightly longer, constriction not deep, sinus open; semicells variable in form, cup-shaped, subspherical or subfusiform, upper angles of the cell produced to form short obtuse processes, projecting horizontally, or sometimes slightly inflexed; cell-wall rough with minute granules, arranged in concentric series round the angles, sometimes with a distinct circle of granules round the base of the semicell. Vertical view 3–9-angled, more often

4-, 5- or 6-angled, sides concave, centre of apex smooth, angles produced to form short truncate processes.

Zygospore large and spherical, with numerous appendages twice dichotomous at the apex.

Length 24–30 μ; breadth, including the processes, 16–48 μ; breadth of isthmus 6–10 μ; diam. zygosp., without processes, 30 μ; with processes, 50 μ.

ENGLAND. — Cumberland! Westmoreland! (*Ralfs*). Lancashire! W. and N. Yorks. (up to 2000 feet)! Cheshire; Leicester (*Roy*). Essex! Warwicks (*Wills*). Gloucester (*Ralfs*). Surrey (zygospores from Devil's Jumps, Frensham Common)! Sussex (*Ralfs*). Hants! (*Roy*). Devon! (*Harris*). Cornwall! (*Marquand*).

WALES.—Abundant (at 2000 feet on Glyder Fach)!

SCOTLAND.—General! (*Roy & Biss.*). At 3500 feet on Lochnagar, Aberdeen! Orkneys! Shetlands!

IRELAND.—Donegal! Mayo and Clare Isle! Galway! Kerry! Dublin and Wicklow (*Arch.*). Antrim! Londonderry!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Galicia and Austria. Hungary. Norway and Finmark. Sweden. Finland. N. Russia. Spitzbergen. Greenland. Siberia (var.). Japan. India. Siam. Java. Celebes. Tasmania. Azores (var.). Sandwich Islands. United States. Brazil.

St. margaritaceum occurs commonly in this country, and has a very wide distribution. It is frequently found in association with *St. muricatum*. Variations in connection with the granules on the apex of the semicell are very common, and apart from forms having the definite granulation of var. *coronulatum* or var. *robustum*, specimens are not uncommon in which some of the granules surrounding the apical smooth area of the semicell are very strongly developed, duplicated, or emarginate, so that the apex of the cell in the front view is more complicated than usual.

Var. **coronulatum** West. (Pl. CL, fig. 10.)

St. margaritaceum var. *coronulatum* West, Alg. N. Wales, 1890, p. 20, f. 3; Lütkem, Desm. Millstättersees, 1900, p. 22; West & G. S. West, Alg. N. Ireland, 1902, p. 57.

Apex of semicell truncate, with a circle of small granules.

Length 25·5 μ ; breadth 20–27 μ ; breadth of isthmus 8 μ.

WALES.—Llyn Padarn, Llyn Idwal, Rhyddu, bog above Capel Curig Lakes and bog between Glyder Fach and Llugwy, Carnarvonshire !

IRELAND.—Loughs Clogher and Dunlewy, Donegal ! Slievecommedagh, Down !

Geogr. Distribution.—Austria. Scandinavia.

Var. **hirtum** Nordst. (Pl. CL, fig. 11.)

St. margaritaceum var. *hirtum* Nordst. Alg. et Char. I, 1880, p. 11, t. I, f. 18 ; Lagerh. Sverig. Desm. 1883, p. 54 ; Börg. Desm. Brasil, 1890, p. 46 (forma) ; West, Alg. W. Ireland, 1892, p. 186 ; Borge, Sao Paulo Alg. 1918, p. 50.

A variety in which the granules ornamenting the cell-wall, including those at the apices of the processes, are developed into short spines.

Length 38 μ ; breadth 44 μ ; breadth of isthmus 12 μ.

WALES.—Yr Orsedd, Carnarvonshire !

IRELAND.—Carrantuohill, Kerry ! Castletown, Cork !

Geogr. Distribution.—Scandinavia. Finland. Australia. Java. Brazil.

Var. **robustum** W. & G. S. West. (Pl. CL, fig. 13.)

St. margaritaceum var. *robustum* West & G. S. West, Alg. S. England, 1897, p. 496, t. 7, f. 14 ; Freshw. Chlorophy. Koh Chang, 1901, p. 95.

Cells stouter than in the type, semicells, without the processes, broadly elliptical, not constricted at the base of the processes, but tapering gradually into them ; in vertical view 4- or 5-radiate, with a small emarginate verruca on either side of the base of each process.

Length 25·5 μ ; breadth 27 μ ; breadth of isthmus 8 μ.

ENGLAND.—Uxbridge, Middlesex !

Geogr. Distribution.—Koh Chang, Siam.

This variety approaches *St. ornatum* Turn. (= *St. margaritaceum* var. *ornatum* Boldt), but has much shorter and stouter

processes. It may also be compared with *St. foliatum* Turn., but Turner's figure is too indistinct to admit of a detailed comparison.

Var. **subcontortum** W. & G. S. West. (Pl. CL, fig. 12.)

St. margaritaceum var. *subcontortum* West & G. S. West, Alg. S. England. 1897, p. 496, t. 17, f. 15–17.

Cells in vertical view 6- or 7-radiate; processes truncate and all curved in one direction as in *St. cyrtocerum*.

Length 26 μ; breadth 25–27 μ; breadth of isthmus 9 μ.

ENGLAND.—Devil's Jumps, Frensham, Surrey!

134. **Staurastrum Chavesii** Bohlin.

(Pl. CXLIX, fig. 12; Pl. CLXVI, fig. 1.)

Staurastrum Chavesii Bohlin, Flor. Algol. d'eau douce d'Açores, 1901, p. 56, f. 15.

? *St. subtile* Schmidle, Beitr. Alp. Alg. 1895, p. 37, t. 16, f. 12.

Cells small, about as long as broad, or up to $1\frac{1}{3}$ times broader than long, including the processes; constriction fairly deep, sinus rounded, almost semicircular; semicells inversely subtrapeziform, apex straight or slightly concave; upper angles of the semicell produced to form short stout diverging processes, biundulate and denticulate, truncate at the apex, and with 4 tiny apical spines; lateral margins of semicell with conspicuous emarginate protuberances at the point of origin of the processes. Vertical view quadrangular, sides concave, angles produced into short nodulose processes; apex with an emarginate projection at the base of each process.

Zygospore unknown.

Length 10–17 μ; breadth, including processes, 15–22 μ; breadth of isthmus 6·5–8 μ.

IRELAND.—Near Ballynahinch, Galway!

Geogr. Distribution.—Austria. Azores.

The distinctive characters of this species are the obtuse sinus and the four emarginate processes on the dorsal surface, one at

the base of each process. These are not very distinct in Pl. CXLIX, fig. 12, but can be recognised in fig. 1, Pl. CLXVI.

135. **Staurastrum cyrtocerum** Bréb.

(Pl. CXLIX, fig. 9; Pl. CL, fig. 4.)

Staurastrum cyrtocerum Bréb. in Ralfs, Brit. Desm. 1848, p. 139, t. 22, f. 10: Arch. in Pritch. Infus. 1861, p. 742; Rabenh. Krypt.-fl. Sachs. 1863, p. 191; Wittr. Gotl. Öl. sötv. Alg. 1872, p. 51; Wolle, Desm. U. S. 1884, p. 128, t. 42, f. 30, 31; Cooke, Brit. Desm. 1887, p. 168, t. 58, f. 3: De Toni, Syll. Alg. 1889, p. 1207; West, Alg. N. Wales, 1890, p. 18, f. 16; Alg. W. Ireland, 1892, p. 181; Alg. Engl. Lake Distr. 1892, p. 20; Roy & Biss. Scott. Desm. 1893, p. 19; Comère, Desm. de France, 1901, p. 155, t. 11, f. 17; West & G. S. West, Alga-fl. Yorks. 1902, p. 104; Alg. N. Ireland, 1902, p. 53; Borge, in Botan. Notiser, 1913, p. 32.
Phycastrum cyrtocerum Kütz. Spec. Alg. 1849, p. 180.
Staurastrum polymorphum var. *cyrtocerum* Rabenh. Flor. Europ. Alg. 1868, p. 210.

Cells rather under medium size, usually somewhat broader than long, including the processes, deeply constricted, sinus rectangular, acute; semicells cup-shaped, ventral margin very tumid, dorsal margin convex, often with a row of minute emarginate granules visible, especially in slightly tilted specimens, upper angles produced to form short stout converging processes, gradually tapering towards their apices, which are tipped with 2 or 3 minute spines; cell-wall rough with minute granules, arranged in concentric series round the angles, and in longitudinal rows across the face of the semicell, median row incomplete; cells often twisted about the isthmus. Vertical view triangular or quadrangular, sides concave, with a row of minute emarginate granules just within each lateral margin; angles produced into short processes, which are often abruptly bent, all in one direction.

Zygospore orbicular, with spines slightly forked at the apex (*Ralfs*).

Length 23–39 μ; breadth, including processes, 33–60 μ; breadth of isthmus 8–11 μ.

England.—Cumberland! Westmoreland! N. and E. Yorks! Cheshire (*Roy*). Burnham Beeches, Bucks! Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Hants! Devon! (*Harris*). Cornwall!

Wales.—Dolbadarn Castle, Capel Curig! (*Cooke & Wills*), Llyn Idwal, Llyn-y-cwm-ffynon, Llyn Bodgynwyd and near Conway, Carnarvonshire! Holyhead, Anglesea! Dolgelly, Merioneth!

Scotland.—Shetlands, Sutherland!, Ross, Inverness, Banff, Aberdeen, Kincardine, Forfar, Perth and Argyle; zygospores from Scotston, Aberdeen (*Roy & Biss.*). Lewis, Outer Hebrides! Hoy, Orkneys! In the plankton!

Ireland.—Donegal! Mayo and Clare Isle! Galway! Kerry! Dublin and Wicklow (*Arch.*). Down!

Geogr. Distribution. — France. Galicia in Austria. Turkey. Norway. Sweden. Denmark. Bornholm. Finland. N. Russia. Spitzbergen. Turkey in Asia. Australia. United States. Colombia. Brazil.

This species is very closely allied to *St. brachycerum* and *St. inflexum*. It is a larger Desmid than either of these, however, and the row of tiny emarginate granules on the apex of the semicell is one of its distinguishing characters. Its short, stout, converging processes, frequently seen in the vertical view to be bent abruptly in one direction, are very characteristic.

Var. **compactum** W. & G. S. West. (Pl. CXLIX, fig. 10.)

St. cyrtocerum var. *compactum* West & G. S. West, Alg. Orkneys & Shetlands, 1905, p. 26, t. 2, f. 29.

Body of semicell much larger in proportion, and processes much shorter.

Length 36 μ; breadth, including processes, 40 μ; breadth of isthmus 11 μ.

Scotland.—Plankton of Loch Trebister, Shetlands!

136. **Staurastrum brachycerum** Bréb.

(Pl. CXLII, figs. 21, 22.)

Staurastrum brachycerum Bréb. Liste Desm. 1856, p. 139, t. 1, f. 24; Arch. in Pritch. Infus. 1861, p. 742; Roy & Biss. Scott. Desm. 1894, p. 180.
St. polymorphum var. *brachycerum* Rabenh. Flor. Europ. Alg. 1868, p. 210; Borge, Süsswasseralgen Franz Josefs-Land, 1899, p. 764; Comère, Desm. de France, 1901, p. 157, t. 11, f. 4.

Cells small, usually a little broader than long, including the processes, deeply constricted, sinus acute and widely open ; semicells almost globular, dorsal margin convex, ventral margin much more turgid ; angles produced to form short, stout, and strongly inflexed processes, tipped with 2 or 3 minute spines and provided with several concentric series of denticulations, which become stronger more remote from the apices of the processes, so that the apex of the semicell seems to be spinous in the front view. Vertical view triangular, sides slightly concave, angles rather acutely rounded, with 3 or 4 series of denticulations, centre of apex smooth, with a small but prominent spine just within each lateral margin at the middle point. Cells usually twisted at the isthmus.

? Zygospore unknown.*

Length 17–23 μ ; breadth, without processes, 10–12 μ; with processes, 20–23 μ ; breadth of isthmus 5–7 μ.

ENGLAND.—Near Senen, Cornwall !

WALES.—Llyn Idwal, Carnarvonshire !

SCOTLAND.—Aberdeen, Kincardine, Forfar and Perth (*Roy & Biss.*).

IRELAND.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Switzerland. Sweden. Franz Josef's Land.

This species is not at all common. It is closely allied to *St. polymorphum*, but is distinguished by its very strongly inflexed processes, and the stronger spine-like denticulations.

137. **Staurastrum eboracense** Turn.

(Pl. CXLIII, fig. 23.)

Staurastrum eboracense Turn. Desm. Notes, 1893, p. 345, f. 11.

Small, with 4 incurved arms, rounded at the ends ; each arm with 3 or 4 rows of conical granules ; sides sinuate ; sinus rounded. It has an apical corona of little verrucæ ; remainder, except arms, smooth (*Turner*).

Zygospore unknown.

* *Cf.* footnote p. 109 (*St. inflexum*).

Length 25 μ; breadth 27 μ; breadth of isthmus 7 μ.
ENGLAND.—Strensall Common, N. E. Yorks. (*Turn.*).

138. **Staurastrum hexacerum** (Ehr.) Wittr.
(Pl. CXLII, figs. 11–14.)

(?) *Desmidium hexaceros* Ehr. Org. kl. Raumes, 1834, p. 293; Inf. 1838, p. 141, t. 10, f. 10.
Binatella tricornis Bréb. Alg. Falaise, 1835, p. 57, t. 8.
Staurastrum tricorne Menegh. Synops. Desm. 1840, p. 225; Ralfs, Brit. Desm. 1848, p. 134, t. 22, f. 11, t. 34, f. 8 a; Arch. in Pritch. Infus. 1861, p. 742; Nordst. Desm. Spetsb. 1872, p. 38; Delp. Spec. Desm. subalp. 1877, p. 145, t. 11, f. 48–50; Kirchn. Alg. Schles. 1878, p. 165; Wolle, Desm. U. S. 1884, p. 126, t. 41, f. 36–38; Cooke, Brit. Desm. 1887, p. 167, t. 58, f. 2; Nordst. Freshw. Alg. N. Zealand, 1888, p. 41, West, Alg. N. Wales, 1890, p. 18; Alg. Engl. Lake Distr. 1892, p. 20; Bohlin, Flor. Alg. d'eau douce d'Açores, 1901, p. 59, f. 19.
Phycastrum tricorne Kütz. Phyc. Germ. 1845, p. 137.
Ph. hexaceros Kütz. Spec. Alg. 1849, p. 180.
Ph. (*Pachyactinium*) *tricorne* Näg. Gatt. einz. Alg. 1849, p. 126.
Staurastrum hexacerum Wittr. Gotl. Öl. sötv. Alg. 1872, p. 51; De Toni, Syll. Alg. 1889, p. 1206; Turn. Freshw. Alg. E. India, 1893, p. 125; Roy & Biss. Scott. Desm. 1893, p. 21; West & G. S. West, Alg. Madagascar, 1895, p. 75; Welw. Afric. Freshw. Alg. 1897, p. 50; Alg. S. England, 1897, p. 495; G. S. West, Alga-fl. Cambridge, 1899, p. 25; W. & G. S. West, Alg. N. Ireland, 1902, p. 52; Alga-fl. Yorks. 1902, p. 52; Freshw. Alg. Orkneys & Shetlands, 1905, p. 26; Freshw. Alg. Burma, 1907, p. 218.

Cells small, about $1\frac{1}{5}$ times broader than long, deeply constricted, sinus open and acute; semicells fusiform or subtriangular, both dorsal and ventral margins convex, tapering towards the angles to form very short processes which end in about 3 minute teeth; cell-wall rough with tiny granules, arranged in concentric series round the angles, granules in the centre of the faces and on the apex of the semicell much reduced. Vertical view usually triangular, lateral margins concave, angles very slightly turgid. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore spherical, armed with numerous long and stout conical spines, very broad at the base and bifid at the apex.

Length 23–28 μ; breadth, including processes, 27–34 μ; breadth of isthmus 7–8 μ; diam. zygosp., without spines, 30 μ; length of spines, about 16 μ.

ENGLAND.—Cumberland! Westmoreland, and in the

plankton of Codale and Easedale Tarns! Lancashire! W., N., and E. Yorks! Cheshire (*Roy*). Cambridge! Warwicks! Worcester! Middlesex! Surrey! Sussex (*Ralfs*). Kent! Hants! (*Roy*). Devon! Cornwall!

WALES.—General and abundant! In the plankton!

SCOTLAND.—General!; zygospores at Scotston Moor, Aberdeen (*Roy & Biss.*). Near Lochmaddy, N. Uist, Outer Hebrides! Orkneys and Shetlands, and also in the plankton!

IRELAND. — Donegal! Mayo and Clare Island! Galway! Kerry, and in the plankton! Dublin and Wicklow (*Arch.*). Louth! Armagh! Lough Neagh! Londonderry!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Norway. Sweden. Bornholm. N. Russia. Faeroes. Iceland. Nova Zembla. Spitzbergen. Greenland. Siberia. Japan. Burma. Siam (var.). Australia. New Zealand. Madagascar. E. Africa. Azores. United States and Alaska. Yukon. Argentine. Patagonia.

St. hexacerum is a very frequent species in this country, and has a world-wide distribution. There have been different views as to the range of *St. hexacerum* (Ehr.) Wittr. and *St. tricorne* Ralfs. The latter includes two distinct forms, and of late years the earlier name *hexacerum* has been almost universally adopted. Nordstedt (in 'Bot. Notiser,' 1906, p. 115) has suggested that Ralfs' name *tricorne* should be adopted for the form described by Ralfs as *St. tricorne* var. β, but this Desmid has been fully described and figured by the late Prof. G. S. West as *St. neglectum*.

Var. **semicirculare** Wittr. (Pl. CXLII, fig. 15.)

St. hexacerum var. *semicirculare* Wittr. Gotl. Öl. sötv. Alg. 1872, p. 52, t. 4, f. 9: De Toni, Syll. Alg. 1889, p. 1206; West & G. S. West, Alga-fl. Yorks. 1902, p. 104; Freshw. Alg. Orkneys & Shetlands, 1905, p. 26.
St. tricorne var. *semicirculare* West, Alg. W. Ireland, 1892, p. 180.
St. hexacerum var. *semilunare* Roy & Biss. Scott. Desm. 1893, p. 21.

Cells nearly twice as large as those of the typical form; semicells in front view subsemicircular: in end view triangular, with the sides slightly concave, angles acutely rounded.

Length 39–41 μ; breadth 40–42 μ; breadth of isthmus 11 μ.

England.—Baildon Moor and Roundhay Park, Leeds, W. Yorks!

Scotland.—Whitestripes, Aberdeen; near Clochnaben, Kincardine (*Roy & Biss.*). Scalloway, Shetlands!

Ireland.—Derryclare Lough, Co. Galway!

Geogr. Distribution.—Sweden. Faeroes.

This variety is distinguished by its larger size, and its apex is also much more convex than in the typical form.

139. **Staurastrum Haaboeliense** Wille.

(Pl. CXLII, figs. 19, 20.)

Staurastrum Haaboeliense Wille, Norges Ferskv. Alg. 1880, p. 42, t. 2, f. 27; Wolle, Desm. U. S. 1884, p. 131, t. 42, f. 51–53; De Toni, Syll. Alg. 1889, p. 1207; West, Alg. N. Wales, 1890, p. 18; Alg. W. Ireland, 1892, p. 181; West & G. S. West, Alg. N. Ireland, 1902, p. 52.

Cells small, about $1\frac{1}{3}$ times broader than long, deeply constricted, sinus acute, opening widely; semicells narrow elliptic-fusiform, slightly attenuated at the angles, forming short stout processes tipped with a group of tiny spines, and with 3 or 4 concentric series of denticulations. Vertical view triangular, sides slightly concave, angles produced and truncate.

Zygospore unknown.

Length 15–18 μ; breadth 24–27 μ; breadth of isthmus 5–7 μ.

England.—Codale Tarn, Westmoreland!

Wales.—Capel Curig, Carnarvonshire!

Ireland.—Near Glenties, Co. Donegal! Ballynahinch, Co. Galway!

Geogr. Distribution.—Norway. Australia. United States.

This species is distinguished from *St. hexacerum* by its relatively shorter, fusiform semicells, and its rather stronger denticulation.

140. **Staurastrum Cerastes** Lund.

(Pl. CL, fig. 16; Pl. CLI, fig. 1.)

Staurastrum Cerastes Lund. Desm. Suec. 1871, p. 69, t. 4, f. 6; Wills in Midland Naturalist, 1881, p. 16, t. 5, f. 8; Wolle, Desm. U. S. 1884, p. 133, t. 43, f. 6, 7; Cooke, Brit. Desm. 1887, p. 173, t. 59, f. 3; De Toni, Syll. Alg. 1889, p. 1213; Roy & Biss. Scott. Desm. 1893, p. 18; West & G. S. West, Some N. Amer. Desm. 1896, p. 268, t. 18, f. 4; Desm. U. S. 1898, p. 318; Brit. Freshw. Phytoplankton, 1909, p. 174.
Staurastrum sp. Archer in Quart. Journ. Micr. Sc. vol. 12, 1872, p. 202.

Cells of medium size, about as long as broad, or sometimes broader, constriction small, an acute notch; semicells almost cylindrical in the lower part, widening considerably upwards; apex strongly convex, lateral angles produced to form stout processes, attenuated towards their apices, and gracefully incurved so that the processes of the two semicells are nearly in contact; upper margin of process verrucose (in some aspects the apex of the semicell also is verrucose), about 9 verrucæ visible along each process, becoming more crowded and simpler towards the apex of the process; lower margin smooth; with another series of verrucæ stretching horizontally from tip to tip of adjacent processes across the face of the semicell, and a further series of granules round its base. Vertical view 3- or 4-angled, angles produced into short tapering processes, lateral margins concave and verrucose, and with another curved series of verrucæ stretching from angle to angle just within each margin. Chloroplast axile, with a central pyrenoid in each semicell.

Zygospore unknown.

Length 48–57 μ; breadth, including processes, 58–72 μ; breadth of isthmus 10–12 μ.

Wales.—Capel Curig, Carnarvonshire! (*Cooke & Wills*). In the plankton!

Scotland.—Near Loch Dawan, Aberdeen (*Roy & Biss.*). Rhiconich, Sutherland!

Ireland.—Galway (*Arch.*).

Geogr. Distribution.—Norway. Sweden. Finland. Ceylon (var.). United States.

This is one of the most beautiful of Desmids. Its granulation

is exquisite, and is one of the most constant characters of the species. It is confined to the western part of the British Isles.

141. **Staurastrum anatinum** Cooke & Wills.

(Pl. CXLVI, fig. 7; Pl. CXLVII, fig. 1.)

Staurastrum anatinum Cooke & Wills, Cooke in Grevillea, 1880, p. 92, t. 139, f. 6; Wills in Midland Naturalist, 1881, p. 18, t. 5, f. 3; Turner, Alg. Strensall Common, 1883, f. 4; Wolle, Desm. U. S. 1884, p. 139, t. 51, f. 1, 2; Cooke, Brit. Desm. 1887, p. 176, t. 61, f. 2; De Toni, Syll. Alg. 1889, p. 1221; West, Freshw. Alg. N. Wales, 1890, p. 280, t. 5, f. 12; Roy & Biss. Scott. Desm. 1893, p. 16; W. & G. S. West, Alg. S. England, 1897, p. 496; Alg. N. Ireland, 1902, p. 54, t. 1, f. 24, 25; Scott. Freshw. Plankton, 1, 1903, p. 530; Further Contrib. Plankt. Scott. Lochs, 1905, p. 487; Brit. Freshw. Phytoplankton, 1909, p. 174 and 168; Borge, Botan. Notiser, 1913, p. 50.

Cells large, about $1\frac{1}{2}$ times broader than long, including the processes, deeply constricted, sinus acute, and opening widely; semicells subfusiform, ventral margin more convex than the dorsal, upper angles produced to form fairly long stout divergent processes, provided with several series of well-marked denticulations and tipped with two or three strong spines; apex of semicell slightly convex, and verrucose. Vertical view triangular or quadrangular, sides straight or very slightly concave, angles produced to form processes, lateral margins verrucose, with another series of about 6 emarginate verrucæ just within each margin.

Zygospore unknown.

Length, without processes, 33–46 μ; with processes, 50–65 μ; breadth, with processes, 80–113 μ; breadth of isthmus 10–15·5 μ.

ENGLAND.—Plankton of Buttermere, Crummock Water and Ennerdale Water, Cumberland! Plankton of Red Tarn, Codale and Easedale Tarns, Westmoreland! New Forest, Hants!

WALES.—Capel Curig! (*Cooke & Wills*) and Llyn-y-cwm-ffynon, Carnarvonshire! In the plankton!

SCOTLAND.—Slewdrum, Blair Glas, between Loch Kinord and Cambas, Aberdeen; near Curran in Strachan, Kincardine; Glen Coe, Argyle (*Roy & Biss.*).

Rhiconich, Sutherland! Common in the plankton of Lochs nan Cuinne, Ghriama and Ruar, Sutherland; Loch Luichart, Ross, and Loch Bairness, Inverness! In the plankton of 10 lochs in Lewis and Harris, Outer Hebrides, and in the plankton of the Shetlands.

Ireland.—Donegal! Galway! Kerry! Londonderry! In plankton, Galway, Kerry, Lough Neagh, and Lough Beg, Londonderry!

Geogr. Distribution.—Norway. Sweden. Finland. Denmark. United States.

There are apparently two distinct forms of this Desmid, although the fact was never commented upon by Professor West. The ordinary form, figured by Cooke, is the larger of the two (*cf.* Pl. CXLVI, fig. 7). It has a broadly fusiform "body," and short, stout diverging processes, tipped with 2 or 3 large spines. The other form (see Pl. CXLVII, fig. 1), is exactly similar in shape, or sometimes the "body" of the semicell is more cup-shaped, but it is much smaller, and sometimes the processes are relatively longer. The granulation of the cell differs from that of the larger form, in that there is only one row of verrucæ across the top of the semicell; in the vertical view the marginal series of verrucæ is wanting, only the row within the margin being present. This form was recorded by Professor West from the plankton of Loch Cuthaig (W. & G. S. West, 'Further Contrib. Plankton Scottish Lochs,' 1905, p. 487), without any reference being made to its differing slightly from the form figured by Cooke & Wills. Professor West's drawing of this Desmid from the above Scottish locality is reproduced on Pl. CXLVII, fig. 1. The writer has also observed this smaller form in material from the lower lake at Capel Curig. These specimens occurred in great abundance along with the larger and typical form. The small forms from Capel Curig are more like the large typical form than the small specimens from Loch Cuthaig, but in both cases the cells are constantly smaller, and the marginal series of verrucæ is wanting in the vertical view. Furthermore there is always a difference in the chloroplasts of the two forms. The larger one has an axile chloroplast with a pyrenoid in each angle of the semicell, *i. e.* typically 3 pyrenoids in the ordinary triangular specimen (see Carter, 'Chloroplasts of Desmids,' IV, 1920, t. xiv, f. 19, 20). The smaller form, however, has only a central pyrenoid in each

semicell. There is a strong resemblance between the small form and var. *longibrachiatum* West (see Pl. CXLVII, fig. 5), and yet it is strange that the two were not considered identical by the Wests, who listed Pl. CXLVII, fig. 1 as typical *St. anatinum.*

St. anatinum is a very handsome Desmid, which, although widely distributed in the British Isles, is only really abundant in North Wales, the west of Ireland, and the north-west of Scotland. Thus it is more frequently found in bogs and in the plankton of lakes lying on the older palæozoic rocks, although it is not exclusively confined to such localities. This fact rather explains its occurrence in Norway and Sweden (where the geological formation is similar to that of the western parts of the British Isles), although it has not yet been recorded for the greater part of continental Europe. It is one of the most characteristic Desmids of Welsh, Scotch and Irish plankton.

Var. **grande** W. & G. S. West. (Pl. CXLVII, fig. 6.)

St. anatinum var. *grande* West & G. S. West, Alg. N. Ireland, 1902, p. 55, t. 1, f. 27; Scott. Freshw. Plankton, I, 1903, p. 530; Further Contrib. Plankt. Scott. Lochs, 1905, p. 504.

Cells larger than in the type, with the processes slightly longer.

Length, without processes, 66 μ; with processes, 105–112 μ; breadth, with processes, 140–148 μ; breadth of isthmus 15·5 μ.

WALES.—In the plankton.

SCOTLAND.—Rhiconich and in the plankton of Loch Shin, Sutherland! Plankton of L. Shiel, Inverness; of Loch Doon, Ayr; of Loch Fadaghoda and 5 other lochs in Lewis and Harris, Outer Hebrides!

IRELAND.—Lough Anna, Donegal!

This variety is one of the most handsome of all *Staurastra*. It is more abundant in plankton than in any other situation.

Var. **Lagerheimii** (Schmidle) W. & G. S. West. (Pl. CXLVII, fig. 4.)

St. Lagerheimii Schmidle, Lappmark Süsswasseralgen, 1898, p. 63, t. 3, f. 10.
St. Landmarkii Huitfeldt-Kaas, Plankton Norske Vande, 1906, p. 155, t. 2, f. 32, 33.
St. anatinum var. *Lagerheimii*, West & G. S. West, Plankton Engl. Lake Distr. 1909, p. 289.

A variety with very short processes, which are less than half the normal length; arrangement of verrucæ as in the type.

Length 53–65 μ; breadth, with processes, 72–88 μ.

England.—In the plankton of Ennerdale Water, Cumberland!; and Easedale Tarn, Westmoreland!

Geogr. Distribution.—Norway. Finmark.

This variety, although not exclusively confined to plankton, prefers this habitat to any other situation.

Var. **biradiatum** West. (Pl. CXLVII, fig. 2.)

St. anatinum subsp. *biradiatum* West, Alg. W. Ireland, 1892, p. 185, t. 24, f. 3.

Cells slightly smaller than in the type, about twice as broad as long, including the processes, deeply constricted, sinus nearly linear for part of its length, semicells subfusiform, ventral margin much more convex than the dorsal, processes not so divergent as in the type. Vertical view fusiform, produced into processes at the poles, lateral margins verrucose, with a series of verrucæ just within each margin.

Length 40 μ; breadth, with processes, 82 μ; breadth of isthmus 8 μ; thickness 23 μ.

Ireland.—Lakes, near Recess, Galway! Adrigole, Cork!

Var. **truncatum** West. (Pl. CXLVI, fig. 8.)

St. anatinum var. *truncatum* West, Alg. W. Ireland, 1892, p. 185, t. 24, f. 2; West & G. S. West, Further Contrib. Plankt. Scott. Lochs, 1905, p. 486.

Semicells more elliptical than in the type, ventral and dorsal margins almost equally convex, but with the apex distinctly flattened, processes inserted lower than in the type, and beginning abruptly, the "body" not tapering so gently into the processes.

Length 50–65 μ; breadth, including processes, 75–100 μ; breadth of isthmus 15–20 μ.

Scotland.—Plankton of Lochs Cuthaig, Fadaghoda,

Stranabhat and an Tomain, Lewis. Lochs Diracleet and Laxadale, Harris, Outer Hebrides!

IRELAND.—Lough Guitane, and in the plankton, Kerry! Plankton of Lough Neagh!

St. anatinum var. *truncatum* is more frequent in plankton than in any other habitat.

Var. **pelagicum** W. & G. S. West. (Pl. CXLVII, fig. 3.)

St. anatinum var. *pelagicum* West & G. S. West, Alg. N. Ireland, 1902, p. 55, t. 1, f. 26; Scott. Freshw. Plankton, I, 1903, p. 530; Further Contrib. Plankton Scott. Lochs, 1905, p. 487.

Cells smaller than in the type, semicells relatively longer (excluding the processes) and more cup-shaped; processes slightly narrower.

Length, without processes, 40–46 μ; with processes, 57–65 μ; breadth, with processes, 65–77 μ; breadth of isthmus 11·5–12·5 μ.

SCOTLAND.—Plankton of Loch Shin, Sutherland!; of Lochs na Criche and Shiel, Inverness!; and of Loch Mor Bharabhais, Lewis, Outer Hebrides!

IRELAND.—Plankton of Lough Beg, Londonderry!

This variety occurs exclusively in plankton, and is readily distinguished from the type by its smaller size, by the different shape of the semicells, and by the narrower and more delicate processes. The granulation is similar to that of the type.

Var. **longibrachiatum** W. & G. S. West. (Pl. CXLVII, fig. 5.)

St. anatinum var. *longibrachiatum* West & G. S. West, Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 504, t. 7, f. 8, 9.

Body of semicell practically smooth beneath the apical row of verrucæ; processes much longer than in the type, tapering gradually to the apices. Lateral margins in end view undulate but not verrucose, with a series of verrucæ just within the margin as in the type.

Length, without processes, 37 μ; breadth, without processes, about 29 μ; with processes, 110–131 μ; breadth of isthmus 11·5 μ.

SCOTLAND.—Plankton of Loch Langabhat. Lewis, Outer Hebrides!

142. Staurastrum sexcostatum Bréb.

(Pl. CL. fig. 14.)

Staurastrum sexcostatum Bréb. in Menegh. Synops. Desm. 1840. p. 228 : Ralfs. Brit. Desm. 1848. p. 129. t. 23. f. 5 : Arch. in Pritch. Infus. 1861, p. 744 : Rabenh. Flor. Europ. Alg. 1868. p. 216 : Nordst. Desm. Arctoae, 1875. p. 36 : Kirchn. Alg. Schles. 1878. p. 165 : Racib. Nonn. Desm. Polon. 1885. p. 29 : Cooke. Brit. Desm. 1887. p. 180. t. 64. f. 1 : De Toni. Syll. Alg. 1889. p. 1232 : West. Alg. N. Wales. 1890. p. 29 : Alg. Engl. Lake Distr. 1892. p. 21 : Roy & Biss. Scott. Desm. 1893. p. 25 : Borge. Süssw. Chlor. Archang. 1894. p. 39 : West & G. S. West. Alg. S. England. 1897, p. 496 : G. S. West. Variation Desm. 1899. p. 406 : Comère. Desm. de France. 1901. p. 153. t. 10. f. 16 : Börg. Alg. Faeroes. 1901. p. 234 : West & G. S. West. Alga-fl. Yorks. 1902. p. 108.
St. Jenneri Ralfs. in Ann. Mag. Nat. Hist. vol. 15. 1845. p. 158. t. 11. f. 8.
Stephanoxanthium sexcostatum Kütz. Spec. Alg. 1849. p. 184.
Didymidium (Staurastrum) sexcostatum Reinsch. Alg. Frank. 1867. p. 106.
Staurastrum (Pleurenterium) sexcostatum Lund. Desm. Suec. 1871. p. 74.
Pleurenterium (Staurastrum) sexcostatum Nordst. Norges Desm. 1873. p. 37.

Cells of medium size. about $1\frac{1}{3}$–2 times longer than broad. deeply constricted. sinus triangular with a minute excavation at its apex : semicells broadly elliptical. or. including the processes. somewhat compressed hexagonal in form. lateral angles very slightly produced. truncate. with a circle of minute acute granules round their apex : both dorsal and ventral margins of lateral angles granulate. with about 3 or 4 granules along each. those near the apex of the semicell becoming emarginate : apex of semicell truncate. irregularly granulate or smooth (according to the aspect) : angles with about 2 concentric series of denticulations : base of semicell also with a circle of prominent granules. Vertical view usually hexagonal. sides concave. angles truncate. scarcely produced. tipped with tiny granules. and with a second series of denticulations : lateral margins smooth. apex with curved series of granules. often emarginate. extending from angle to angle just within the margins.

Zygospore unknown.

Length 40–65 μ : breadth. including processes. 34–47·5 μ : breadth of isthmus 14–25 μ.

ENGLAND.—Brother's Water. Westmoreland! Den-

holme, W. Yorks ! Mickle and Cronkley Fells, N. Yorks ! Warwicks (*Wills*). Gloucester (*Ralfs*). Esher West End Common, Surrey ! Sussex (*Ralfs*). Dartmoor, Devon (*Harris*). Cornwall (*Marquand*).

WALES.—Snowdon, Llyn Padarn, and Y Foel Fras, Carnarvonshire ! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Sutherland, Aberdeen, Kincardine, Forfar, and Perth! (*Roy & Biss.*). Near House of Hill, Wigtown!

IRELAND.—Lough Anure, Donegal ! Mayo and Clare Isle ! Lough Guitane, Kerry ! Adrigole, Cork !

Geogr. Distribution.—France. Germany. Galicia in Austria. Portugal. Norway. Sweden. Poland (var.). N. Russia. Faeroes. Spitzbergen. Greenland.

Var. **productum** West. (Pl. CL, fig. 15.)

? *St. tuberculatum* Benn. Alg. Engl. Lake Distr. 1886, p. 12, t. 2, f. 24.
St. aculeatum var. *ornatum* f. *simplex* Boldt, Desm. Grön. 1888, p. 38, t. 2, f. 49.
St. sexcostatum subsp. *productum* West, Alg. Engl. Lake Distr. 1892, p. 21, f. 34 ; Alg. S. England, 1897, p. 496 ; Schmidle, Alg. Geb. Oberrheins, 1893, p. 552 ; Bohlin, Flor. Algol. d'eau douce d'Açores, 1901, p. 62, t. 1, f. 24 ; West & G. S. West, Alga-fl. Yorks. 1902, p. 108 ; Borge, Botan. Notiser, 1913, p. 51.

Cells relatively broader than in the type, about as long as broad, including the processes ; processes short and truncate (longer, however, than in the type), with a circle of about 6 acute granules at their tip ; base of semicell with a circle of acute granules ; vertical view 6-radiate, arrangement of granules essentially similar to that of the type, but cell-wall very much more verrucose, granules tending to become scattered.

Length 40–43 μ ; breadth 43 μ ; breadth of isthmus 16–17 μ.

ENGLAND. — Borrowdale, Cumberland ! Bowness, Brother's Water and Helvellyn (at 2400 feet), Westmoreland ! Cocket Moss near Giggleswick, and bog 2 miles south of Clapham, W. Yorks ! Cronkley Fell ; bog near Widdale Beck, and Pilmoor, N. Yorks ! Bog near Longmoor Pool, Sutton Park, Warwickshire ! New Forest, Hants ! Near the Lizard, Cornwall !

WALES.—Moel Siabod, Carnarvonshire !

Scotland.—Sutherland, Ross, Aberdeen, Kincardine, Forfar !, Perth !, Dumbarton, Argyle and Renfrew (*Roy & Biss.*). North of Fort Augustus, Inverness !

Ireland.—Carrantuohill, Kerry ! Slieve Donard, Down (at 2000 feet) !

Geogr. Distribution.—Germany. Sweden. Greenland. Azores.

This variety differs from the type chiefly in its broader semicells and rather longer processes, and in the greater development of the verrucæ.

143. **Staurastrum natator** West.

(Pl. CXLVII, fig. 7.)

Staurastrum natator West, Alg. W. Ireland, 1892, p. 183, t. 23, f. 14; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 202.

Cells of medium size, about twice as long as broad, excluding the processes, constriction fairly deep, sinus small, acute, semicells subquadrangular, broadening slightly upwards, lateral margins slightly crenate, apex with three large mucronate or emarginate verrucæ, upper angles produced to form long diverging processes, tipped with 3 minute spines and with many series of denticulations, centre of each face with a rounded protuberance ornamented with about 7 or 8 granules arranged in a circle. Vertical view rounded or rhomboidal, elongated at the poles to form long processes, with a prominent subtruncate protuberance in the middle of each lateral margin, and 2 series of 3 verrucæ on the apex. Semicells in side view rounded, with a protuberance on each side, and a process projecting vertically between two apical verrucæ.

Zygospore unknown.

Length, without processes, 34–38·5 μ; with processes, 53–67 μ; breadth at base of semicell 15–20 μ; at apex, excluding the processes, 20–25 μ; breadth, including processes, 57–75 μ; length of processes 20–32·5 μ; breadth of isthmus 8–12·5 μ; thickness 19–21·5 μ.

Scotland.—Rhiconich, Sutherland !

IRELAND.—Derryclare Lough, and in lakes, Clifden to Roundstone, Galway! Near Castlebar, Mayo.

Geogr. Distribution.—Scandinavia. Finland (form). United States (var.).

This rare and beautiful Desmid is only found in bogs in the region of the older palæozoic rocks. It is not closely allied to any other British species, but is similar in some respects to *St. brachioprominens* Börg. ('Desm. Brasil,' 1890, p. 952, t. 5, f. 22). Sometimes it is further ornamented with 2 rings of granules near the base of the semicell. Grönblad ('Desm. Keuru' 1920, p. 70, t. 3, f. 109, 110) records a trigonal form of this species, which, however, seems to differ in other ways from the form originally described.

144. **Staurastrum irregulare** West.
(Pl. CXLIX, fig. 7.)

Staurastrum irregulare West, New Brit. Freshw. Alg. 1894, p. 12, t. 2, f. 49, 50; Johns. New Rare Desm. U. S. I, 1894, p. 288, t. 211, f. 10; West & G. S. West, Desm. U. S. 1898, p. 314; Bohlin, Flor. Algol. d'eau douce d'Açores, 1901, p. 56, f. 14; Gutw. Alg. Ins. Java, 1902, p. 600, t. 40, f. 64.

Cells small, slightly longer than broad, constriction fairly deep, with a minute median incision; semicells inversely trapeziform, apex smooth and slightly concave, upper angles produced to form short diverging processes, with denticulate nodulose margins, and bidenticulate apices; vertical view biradiate, very slightly swollen in the middle, with a truncate and scrobiculate process on each side; side view of cell fusiform with a deep constriction, and a scrobiculate process on each side near the base of the semicell. Cells often twisted so as to present a very irregular and distorted appearance.

Zygospore unknown.

Length, without processes, 9·4–9·6 μ; with processes, 15·3–18·2 μ; breadth, including processes, 13·5–17·3 μ; breadth of isthmus 4·8–5·7 μ; thickness 6·6–7·7 μ.

ENGLAND.—Plankton of Brother's Water, Westmoreland! Pilmoor, N. Yorks!

SCOTLAND.—Rhiconich, Sutherland! Glen Nevis, Inverness!

Ireland.—Lough Gartan and near Lough Magrath, Donegal! Ballynahinch, Galway!

Geogr. Distribution.—Scandinavia. Java (var.). Azores. United States.

This characteristic little species is closely allied to *St. tetracerum* Ralfs, from which it is readily distinguished by the protuberance in the centre of each face of the semicell.

145. **Staurastrum Arachne** Ralfs.

(Pl. CL, fig. 1.)

Staurastrum Arachne Ralfs, in Ann. Mag. Nat. Hist. vol. 15, 1845, p. 157, t. 11, f. 6; Brit. Desm. 1848, p. 136, t. 23, f. 6; Arch. in Pritch. Inf. 1861, p. 744; Rabenh. Krypt.-fl. Sachs. 1863, p. 191; Flor. Europ. Alg. 1868, p. 210; Lund. Desm. Suec. 1871, p. 69; Kirchn. Alg. Schles. 1878, p. 168; Turn. Alg. Strensall Common, 1883, f. 20; Wolle, Desm. U.S. 1884, p. 129, t. 42, f. 38–42; Boldt, Sibir. Chloroph. 1885, p. 118; Cooke, Brit. Desm. 1887, p. 182, t. 63, f. 4; Nordst. Desm. Bornholm, 1888, p. 206; De Toni, Syll. Alg. 1889, p. 1229; West, Alg. W. Ireland, 1892, p. 187; Roy & Biss. Scott. Desm. 1893, p. 16; West & G. S. West, Desm. U.S. 1898, p. 316; Cushman in Rhodora, v. 7, 1905, p. 201; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 203.
Goniocystis (*Pentasterias*) *Arachne* Hass. Brit. Alg. 1845, p. 355, t. 85, f. 8.
Phycastrum Arachne Kütz. Spec. Alg. 1849, p. 181.
Ph. (*Stenactinium*) *Arachne* Näg. Gatt. einz. Alg. 1849, p. 128.

Cells small, about twice as broad as long, including the processes, deeply constricted, sinus acute; semicells cup-shaped, ventral margin strongly ventricose, dorsal margin nearly straight or slightly convex, upper angles produced to form long slender processes, nearly as long as the cell itself, each process tipped with about 3 minute spines, and rough with numerous concentric series of granules. Vertical view usually 5-angular, angles produced to form long processes, sides concave, sometimes with a few scattered granules just within each lateral margin between the processes.

Zygospore unknown.

Length 26 μ; breadth, without processes, about 16 μ; with processes, 40–55 μ; length of processes 14–18 μ; breadth of isthmus 8–9 μ.

England.—Strensall Common, N. Yorks (*W. B. Turner*). Thursley Common, Surrey! New Forest, Hants!

WALES.—Llyn-y-cwm-ffynon! and Capel Curig! (*Cooke & Wills*), Carnarvonshire. Dolgelly (*Ralfs*), Merioneth. In the plankton

SCOTLAND.—From several localities in Aberdeen; Nigg, Craithes, and Curran, Kincardine; Glen Coe, Argyle (*Roy & Biss.*). Rhiconich, Sutherland! Loch Bairness, Inverness! Lochs Fadaghoda and Stranabhat, Lewis, Outer Hebrides! In the plankton!

IRELAND.—Dungloe, Donegal! Derryclare Lough, Athrey Lough, Ballynahinch, and in Lakes, Clifden to Roundstone, Galway! Adrigole, Co. Cork! In the plankton!

Geogr. Distribution.—France. Germany. Galicia and Austria. Italy. Norway. Sweden. Finland. Denmark. Bornholm. Faeroes. Greenland. Japan. Australia. Central Africa. United States.

St. Arachne is a most characteristic species easily recognised by its long slender processes, which, when the individual is in an oblique position, give the appearance of a spider with long untidy legs. It is not at all general in its distribution, but sometimes occurs in profusion in the western areas of the British Isles, having a decided preference for the older palæozoic and precambrian formations.

Var. **curvatum** W. & G. S. West. (Pl. CL, fig. 2.)

St. Arachne var. *curvatum* West & G. S. West, Scott. Freshw. Plankt. I, 1903, p. 549, t. 18, f. 9; Further Contrib. Plankton Scott. Lochs, 1905, p. 487, t. 1, No. 2, f. 5.

Processes bent slightly, but distinctly upwards; in end view 4- or 5-radiate.

Length 30 μ; breadth, without processes, 18 μ; with processes, 57–70 μ; breadth of isthmus 9 μ.

SCOTLAND.—Plankton of Lochs nan Cuinne and Ruar, Sutherland!

This variety is either 4- or 5-radiate, and differs from all other forms of *St. Arachne* in the outwardly curved processes.

Var. **arachnoides** W. & G. S. West. (Pl. CL, fig. 3.)

St. arachnoides West, Alg. W. Ireland, 1892, p. 186, t. 24, f. 4.
St. Arachne var. *arachnoides* West & G. S. West, Alg. N. Ireland, 1902, p. 56.

Differs from the type in the possession of an apical ring of about 9 or 10 verrucæ, which are visible as emarginate granules across the apex in the front view.

Length 37 μ; breadth, without processes, 15–20 μ; breadth, including processes, 55–71 μ; length of processes 20–27 μ; breadth of isthmus 9 μ.

Ireland.—Lough Machugh, Donegal! In lakes, Clifden to Roundstone, Galway!

146. **Staurastrum Ophiura** Lund.

(Pl. CLII, figs. 1, 2.)

Staurastrum Ophiura Lund. Desm. Suec. 1871, p. 69, t. 4, f. 7; Nordst. Norges Desm. 1873, p. 35; Wolle, Desm. U. S. 1884, p. 134, t. 43, f. 10, 11; Cooke, Brit. Desm. 1887, p. 172 (descr. only); De Toni, Syll. Alg. 1889, p. 1212; West & G. S. West, Some N. Amer. Desm. 1896, p. 268, t. 18, f. 16; Scott. Freshw. Plankton, I, 1903, p. 550; Notes Alg. III, 1903, p. 11; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 487; Phytoplankt. Engl. Lake Distr. 1909, p. 290; Borge, Botan. Notiser, 1913, p. 32.

Cells large, about twice as long as broad, not including the processes, constriction slight; semicells cuneate, broadening upwards; apex slightly convex, upper angles produced to form long slender processes, parallel, or very slightly converging with undulate and denticulate margins, upper margin rougher than the lower; semicell with a ring of papillæ at its base, of which about 7 are visible, and with a circle of large conical granules or flattened verrucæ on its apex. Vertical view 4–9-radiate (in British specimens usually 6–9), processes very long and gradually tapering to their apices, which are provided with about 3 minute spines, and with numerous series of denticulations which become larger towards the base of the process; apex with a circle of large conical nodules or flattened verrucæ, which usually alternate with the processes. Chloroplast axile, with a central pyrenoid, and a number of ridges.

Zygospore unknown.

Length 65–91 μ; breadth, without processes, 34–46 μ; including processes, 128–169 μ; breadth of isthmus 19·5–26 μ.

ENGLAND.—Near Ambleside (*Archer*) and plankton of Easedale Tarn !. Westmoreland.

WALES.—Llyn Ogwen, Carnarvonshire !

SCOTLAND.—Plankton of Lochs Shin, Ghriama, nan Cuinne, and a Gharbh Bhaid Mhoir, Sutherland ! ; of Loch Shiel, Inverness ! ; of Loch Tay, Perth ! ; of Lochs Cuthaig, Fadaghoda, Stranabhat, an Sgath, and an Tomain, Lewis, and Lochs Diracleet and Laxadale, Harris, Outer Hebrides ! In bogs, Sutherland and Outer Hebrides !

IRELAND.—Connaught (*Adams*).

Geogr. Distribution.—Norway. Sweden. Finland. United States.

This beautiful Desmid is a distinctly western type,* occurring only in the region of the older and harder rocks in the western parts of the British Islands. It is a general, but not abundant constituent of Scottish plankton, and is also frequently found in permanent *Sphagnum* bogs. The apical verrucæ are subject to considerable variation, being sometimes large smooth conical nodules, and sometimes irregular lobed warts.

Var. **cambricum** W. & G. S. West. (Pl. CLII, figs. 3, 4.)

St. Ophiura Cooke in Grevillea, 1880, t. 140, f. a–c : Brit. Desm. 1887, t. 59, f. 1 (not descr. on p. 172) ; West, Alg. N. Wales, 1890, p. 18, f. 15.
St. Ophiura var. *cambricum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 12.

Cells about $1\frac{1}{3}$ times broader than long, including the processes, which are relatively shorter than in the type ; apex of semicell more convex, with a circle of conical nodules.

Length 75–80 μ ; breadth, including processes, 98–110 μ ; breadth of isthmus 16–18·5 μ.

WALES.—Capel Curig ! (*Cooke & Wills*) and in the plankton, Carnarvonshire !

This variety differs from the type chiefly in its relatively shorter processes. The conical nodules of the apex are found occasionally also in the typical form instead of flattened verrucæ, and cannot be considered characteristic of var. *cambricum*.

* See p. 18.

147. **Staurastrum verticillatum** Arch.

(Pl. CLI, figs. 7, 8.)

Staurastrum verticillatum Arch. in Quart. Journ. Micr. Sci. vol. 9, 1869, p. 196; Cooke, Brit. Desm. 1887, p. 177, t. 61. f. 3; De Toni, Syll. Alg. 1889, p. 1223; West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 549, t. 14, f. 7.

Cells large, nearly 3 times longer than broad, excluding the processes, constriction slight, sinus acute; semicells almost cylindrical, slightly broader at the apex, which is convex and almost smooth; upper angles produced to form long, strongly divergent processes tipped with 2 or 3 minute teeth, and with many series of denticulations, the upper margin of the process considerably rougher than the lower; semicells with a ring of papillæ at the base, about 7 of which are visible in the front view. Vertical view 8–10-radiate, processes very long and tapering gradually, with denticulations stronger towards the base of the process, apex of semicell with a pair of large verrucæ near the base of each process.

Zygospore unknown.

Length, without processes, 76–79 μ; with processes, 136–143 μ; breadth, without processes, about 26–28 μ; with processes, 124–130 μ; breadth of isthmus 20 μ. [Note.—The breadth without processes given by W. & G. S. W., 'Scott. Freshw. Plankt.' I, 1903, p. 549, as 36–38 μ is erroneous.]

SCOTLAND.—Rhiconich, Sutherland! Plankton of Loch Mor Bharabhais, Lewis, Outer Hebrides!

IRELAND.—Near Maam, Galway (*Arch.*).

Geogr. Distribution.—France. Norway.

The front view of this species is so characteristic that it can readily be distinguished from both *St. Ophiura* Lund. and *St. Archerii* West. Its processes are more slender and more divergent than those of the latter species.

148. **Staurastrum Archerii** West.

(Pl. CLIII, figs. 6, 7.)

Staurastrum Archerii West, Alg. W. Ireland, 1892, p. 183, t. 23, f. 15.

Cells large, about twice as long as broad, excluding

the processes, constricted at the middle, sinus short and obtuse; semicells broadly cuneate, or cup-shaped, apex smooth and convex; lateral margins nearly straight, upper angles produced to form very long slender processes, gently curved obliquely upwards, tipped with 3 small spines, and with many transverse series of denticulations. Vertical view 9- or 10-radiate, apex smooth.

Zygospore unknown.

Length, without processes, 69–78 μ; with processes, 90–120 μ; breadth, without processes, 43–48 μ; with processes, 130–140 μ; greatest length of processes, 50 μ; breadth of isthmus 24–26 μ.

IRELAND.—Ballynahinch and Derryclare Lough, Galway!

This species is readily distinguished from *St. Ophiura* Lund. by its smooth apex, and slightly diverging processes. From *St. verticillatum* Arch. it is distinguished by the different form of the semicells.

149. **Staurastrum elongatum** Barker.

(Pl. CLI, figs. 2–5.)

Staurastrum elongatum Barker, in Quart. Journ. Micr. Sci. vol. 9, 1869, p. 424; Wolle, Desm. U.S. 1884, p. 130, t. 46, f. 11, 12; Cooke, Brit. Desm. 1887, p. 172, t. 59, f. 2; De Toni, Syll. Alg. 1889, p. 1212; Roy & Biss. Scott. Desm. 1893, p. 19; West & G. S. West, Desm. U. S. 1898, p. 317; G. S. West, Brit. Freshw. Alg. 1904, p. 172, f. 65 E; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 202.
St. terebrans Nordst. Norges Desm. 1873, p. 34, t. 1, f. 16.

Cells large, about 6 times longer than broad, excluding the processes, constriction slight, sinus acute and open; semicells elongated cyathiform, considerably swollen at the base, where there are 3 or 4 close decussating rows of granules; apex convex, somewhat truncate in the middle, with 2 emarginate verrucæ, and two others just beneath; sides concave; upper angles produced to form short stout processes, parallel or very slightly divergent, tipped with 3 minute spines, and with 2 or 3 series of acute denticulations. Vertical view triangular, sides concave with 2 median emarginate verrucæ, and

2 others just within the margin; angles produced to form short processes.

Zygospore unknown.

Length, 60–77 μ; breadth, including processes, 42–48 μ; breadth at base of semicell 14–15 μ; breadth of isthmus 9 μ.

SCOTLAND.—Poolewe, Ross; Glen Coe, Argyle (*Roy & Biss.*). Rhiconich, Sutherland!

IRELAND.—Kylemore, Galway, and Glengariff, Cork (*Arch.*).

Geogr. Distribution.—Norway. Sweden. United States.

This characteristic species cannot be confused with any other, the form and proportions of its cells being most striking. It is extremely localized in its distribution, and is only known from one or two localities in the western areas of the British Isles.

150. **Staurastrum barbaricum** W. & G. S. West.

(Pl. CLI, fig. 6.)

Staurastrum barbaricum West & G. S. West, Alg. N. Ireland, 1902, p. 53, t. 1, f. 23.

Cells small, $1\frac{1}{4}$ times broader than long, including the processes, deeply constricted, sinus open; semicells elliptic-obsemicircular, lower margins biundulate, apex convex and undulate, angles produced to form very short slightly diverging processes, with 3 tiny spines at their apex, and 2 series of denticulations; vertical view triangular, sides concave, angles deeply cleft, each forming two short slightly diverging processes.

Zygospore unknown.

Length 30 μ; breadth, including the processes, 38–41 μ; breadth of isthmus 8 μ.

IRELAND.—Bog near Lough Neagh, Londonderry!

This remarkable *Staurastrum* stands alone in the possession of two denticulate processes at each angle, arranged in a horizontal plane. These processes, which are terminated by 3 small teeth, each possess 2 rings of denticulations, and are disposed in precisely the same manner as the smooth processes of *St. læve* Ralfs, and *St. fissum* Turn.

151. **Staurastrum vestitum** Ralfs.

(Pl. CLI, figs. 9–11; Pl. CLII, figs. 5, 6.)

Staurastrum vestitum Ralfs, Brit. Desm. 1848, p. 142, t. 23, f. 1; Arch. in Pritch. Inf. 1861, p. 742; Rabenh. Krypt.-fl. Sachs. 1863, p. 193; Flor. Europ. Alg. 1868, p. 218 (in part); Jacobs. Desm. Danem. 1875, p. 207; Delp. Spec. Desm. subalp. 1877, p. 159, t. 12, f. 46–49; Kirchn. Alg. Schles. 1878, p. 167; Wolle, Desm. U.S. 1884, p. 138, t. 45, f. 28–30; Cooke, Brit. Desm. 1887, p. 175, t. 60, f. 3; De Toni, Syll. Alg. 1889, p. 1218; West, Alg. Engl. Lakes. 1892, p. 20; Roy & Biss. Scott. Desm. 1893, p. 26; West & G. S. West, Alg. S. England, 1897, p. 496; Schmidle, Lappmark Süsswasseralgen, 1898, p. 63; G. S. West, Variation Desm. 1899, pp. 374, 395; West & G. S. West, Alga-fl. Yorks. 1902, p. 106; Alg. N. Ireland, 1902, p. 54.

Didymidium (Staurastrum) vestitum Reinsch, Alg. Frank. 1867, p. 167.

Staurastrum vestitum var. *ornatum* Istv. Diag. praev. Alg. nov. Hung. 1887, p. 240.

Cells of medium size, about $1\frac{1}{2}$–2 times broader than long, deeply constricted, sinus open; semicells subfusiform, lower margin ventricose, apex slightly convex with about 6 emarginate granules, and two prominent emarginate or bifurcate spines just under the apex; angles gradually produced to form fairly long processes, usually nearly horizontal or slightly converging, tipped with 3 strong spines and provided with several concentric series of denticulations. Vertical view triangular, angles produced into denticulate processes, lateral margins concave, with two prominent bifurcate spines projecting from the middle of each, and sometimes with smaller emarginate verrucæ on each side; with a dorsal series of emarginate granules just within each lateral margin.

Zygospore globose, with numerous spines bifurcate at the apex (*Wolle*).

Length 28–43 μ; breadth, including processes, 46–90 μ; breadth of isthmus, about 9 μ.

England.—Near Bowness! (*Bissett*), Deep Vale, Loughrigg, and in the plankton of Easedale Tarn, Westmoreland! Riccall Common, E. Yorks! Hawkshead, Lancashire! Thursley Common, Surrey! Near Pulborough, Sussex (*Ralfs*). New Forest, Hants! Dartmoor, Devon (*Harris*). St. Just, Cornwall!

Wales.—Capel Curig! (*Cooke & Wills*) and Llyn-

y-cwm-ffynon, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*). In the plankton!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine and Perth (*Roy & Biss.*).

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*). Down!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Galicia in Austria. Hungary. Italy. Norway. Sweden. Denmark. Bornholm. Finland. Poland. S. Russia. Japan. Australia. Azores. United States. N. W. Canada. Brazil.

Few species exhibit so much variation as *St. vestitum* whilst retaining at the same time their distinctive features. The main diagnostic character of the species is the possession of the pair of furcate spines in the middle of the lateral margins of the vertical view. These spines themselves are subject to much variation, being sometimes simple aculei, at other times furcate to their base, or more rarely, doubly furcate. The general plan of the arrangement of the spines and of the emarginate verrucæ is precisely like that of *St. aculeatum*. The angles of *St. vestitum*, which possess 3 well-marked divergent spines at their apices, are more produced than those of *St. aculeatum*, and as a rule, the two median spines of the dorsal series become converted into emarginate warts. Of the lateral series of spines, which are such a marked feature of *St. aculeatum*, either the two median spines only remain in *St. vestitum*, or they are much more prominent than the rest. These are the characteristic furcate spines mentioned above. No matter how variable the lateral series of spines may be (including the furcate ones), those of the dorsal series are always disposed on the same plan. The front view of typical *St. vestitum* resembles very closely that of some forms of *St. aculeatum*, but in the majority of specimens of the former species, the angles are produced into processes of varying length. In some of these the processes are very long, making the total width of the cell as much as 90 μ; and in others they are very short, so that a breadth of about 46 μ only is attained. Archer has reported the occurrence of a biradiate form of *St. vestitum*.

Var. **subanatinum** W. & G. S. West. (Pl. CLIII, fig. 5.)

St. vestitum var. *subanatinum* West & G. S. West, Alg. N. Ireland, 1902, p. 54, t. 1, f. 28.

A variety with long and slightly diverging processes, and the arrangement of the verrucæ very similar to that of *St. anatinum*.

Length, without processes, 35 μ ; breadth, including processes, 86–102 μ ; breadth of isthmus 13·5 μ.

IRELAND.—Near Glenties, Donegal ! Arderry Lough, Galway !

In the front view this variety bears a striking resemblance to *St. anatinum*, but in the end view it has the characteristic bifurcate spines of *St. vestitum*.

Var. **semivestitum** West. (Pl. CLII, figs. 7, 8.)

St. vestitum var. *semivestitum* West, Alg. Engl. Lake Distr. 1892, p. 20, f. 38 ; West & G. S. West, Alg. S. England, 1897, p. 496.

Cells smaller than in the type ; apex of semicell nearly straight ; in vertical view triangular, processes bent round all in one direction as in *St. cyrtocerum*, with one furcate spine at the base of the convex side of each process.

Length, including spines, 20–28 μ ; breadth, including processes, 34–42·5 μ ; breadth of isthmus 4–8 μ.

ENGLAND.—Loughrigg and Brandreth, Westmoreland! Puttenham Common, Surrey ! Gunwen Moor, Cornwall !

In this small variety the spines are very much reduced. The whole of the dorsal series is usually absent, and frequently the whole of the lateral series as well, with the exception of one bifurcate spine on the lateral margin. Some forms closely resemble *St. controversum*, but the processes are longer and quite straight.

152. **Staurastrum aculeatum** (Ehrenb.) Menegh. (Pl. CLIII, figs. 1–4.)

Desmidium aculeatum Ehrenb. Inf. 1838, p. 142, t. 10, f. 12.
Staurastrum aculeatum Menegh. Synops. Desm. 1840, p. 226 ; Ralfs, Brit. Desm. 1848, p. 142, t. 23, f. 2 ; Arch. in Pritch. Infus. 1861, p. 742 ; Rabenh. Krypt.-fl. Sachs. 1863, p. 194 ; Lund. Desm. Suec. 1871, p. 68 ; Jacobs. Desm. Danem. 1875, p. 207 ; Delp. Spec. Desm. subalp. 1877, p. 63, t. 13, f. 3–5 ; Kirchn. Alg. Schles. 1878, p. 166 ; Wolle, Desm. U. S.

1884, p. 140, t. 45, f. 1–3; Cooke, Brit. Desm. 1887, p. 174, t. 60, f. 2; Hansgirg, Prodr. Alg. Böhm. 1888, p. 215; De Toni, Syll. Alg. 1889, p. 1216; Anders. Sverig. Chlorophy. 1890, p. 12; Lütkem. Desm. Attersees, 1893, p. 568; Roy & Biss. Scott. Desm. 1893, p. 16; West & G. S. West, Alg. S. England, 1897, p. 496; Schröder, Beitr. Algen Riesengebirge, 1898, p. 42; G. S. West, Variation Desm. 1899, p. 393, t. 11, f. 28–32; Lütkem. Desm. Millstättersees, 1900, p. 76; Comère, Desm. de France, 1901, p. 151, t. 11, f. 12; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 203.

Goniocystis (Trigonocystis) aculeata Hass. Brit. Freshw. Alg. 1845, p. 353, t. 84, f. 12.

Phycastrum aculeatum Kütz. Phyc. Germ. 1845, p. 138; Spec. Alg. 1849, p. 182.

Ph. (Stenactinium) aculeatum Näg. Gatt. einz. Alg. 1849, p. 128.

Didymidium (Staurastrum) aculeatum Reinsch, Alg. Frank. 1867, p. 176, (in part).

Staurastrum aculeatum var. *Ehrenbergii* Rabenh. Flor. Europ. Alg. 1868, p. 218.

Cells of medium size, about as long as broad, or up to $1\frac{1}{3}$ times broader than long, deeply constricted, sinus acute and open; semicells subelliptical or subfusiform, dorsal and ventral margins almost equally convex, though the ventral margin is not infrequently slightly more convex than the dorsal; lateral angles slightly or not at all produced, terminating in 3 or 4 strong spines and sometimes with one or two series of denticulations beneath; apex of semicell with a dorsal series of spines, the median ones being sometimes emarginate; semicells also with a lateral series of spines running horizontally from angle to angle across the face of the semicell. Vertical view triangular or quadrangular, sides nearly straight, angles scarcely produced, tipped with 3 or 4 strong spines; lateral margins with a row of spines, and with a dorsal series of spines just within each lateral margin.

Zygospore globose, furnished with long spines forked or dichotomous at the apex (*Lund.*).

Length 33–50 μ; breadth, including spines, 48–60 μ; breadth of isthmus 12–16 μ; diam. zygosp., without spines, 44 μ; length of spines, 18 μ.

England.—Wastdale, Cumberland! Loughrigg! and Bowness!, Westmoreland (*Ralfs*). Hawkshead, Lancashire! Strensall, N. Yorks (*W. B. Turner*). Thursley Common, Surrey! Sussex (*Ralfs*). New Forest, Hants!

Woodbury Common (4-radiate), Devon! (*Harris*). Withiel, Cornwall!

WALES.—Capel Curig! (*Cooke & Wills*). Llyn Padarn! and Pen-y-gwryd (*Roy*), Carnarvonshire. In the plankton!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar and Perth (*Roy & Biss.*).

IRELAND.—Near Glenties and Lough Gartan, Donegal! Clare Island, Mayo! Ballynahinch, Galway! Carrantuohill, Kerry! Castletown, Cork! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Servia. Italy. Norway. Sweden, Denmark. Finland. N. Russia. Nova Zembla. Greenland. Siberia. Japan. Burma. Australia. New Zealand. United States. Patagonia. Antarctic.

The distinctive feature of *St. aculeatum* is the possession of two series of spines stretching from angle to angle of the cell, a dorsal series on the apex, and a lateral series lower down. The median spines of the dorsal series are frequently emarginate, and some of the spines of the lateral series may occasionally be duplicated, or very much reduced in size, but the two series can always be recognised.

153. **Staurastrum controversum** Bréb.

(Pl. CLIV, figs. 1–4.)

Staurastrum controversum Bréb. in Menegh. Synops. Desm. 1840, p. 228; Ralfs, Brit. Desm. 1848, p. 141, t. 23, f. 3; Arch. in Pritch. Inf. 1861, p. 742; De Not. Desm. Ital. 1867, p. 49, t. 4, f. 39; Wolle, Desm. U. S. 1884, p. 143, t. 45, f. 24, 25; Cooke, Brit. Desm. 1887, p. 173, t. 60, f. 1; De Toni, Syll. Alg. 1889, p. 1216; West, Alg. N. Wales, 1890, p. 19, f. 22; Alg. W. Ireland, 1892, p. 184; Roy & Biss. Scott. Desm. 1893, p. 18; Schmidle, Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895, p. 82, t. 1, f. 22; West & G. S. West, Alg. S. England, 1897, p. 496; Lütkem. Desm. Millstättersees, 1900, p. 20, t. 1, f. 49; Comère, Desm. de France, 1901, p. 151, t. 11, f. 13; West & G. S. West, Alga-fl. Yorks. 1902, p. 106.

St. aculeatum Ralfs, in Ann. Mag. Nat. Hist. vol. 15, 1845, p. 156, t. 11, f. 13.

St. aculeatum var. *controversum* Rabenh. Flor. Europ. Alg. 1868, p. 217; Jacobs. Desm. Danem. 1875, p. 207.

Cells usually under medium size, about as long as broad, or up to $1\frac{1}{3}$ times broader than long, deeply con-

stricted, sinus acute, widening rapidly outwards ; semicells subelliptical or fusiform, lower margin ventricose, dorsal margin strongly convex ; lateral angles gradually produced to form short, stout, strongly incurved processes, tipped with about 3 spines and with 2 or 3 series of denticulations beneath ; apex with a dorsal series of spines, often deeply bifid, stretching from angle to angle, and frequently with a lateral series just beneath as well. Vertical view 3–5-radiate, angles produced into short tapering processes all bent abruptly in one direction ; lateral margins concave with a marginal row of spines, often displaced by the twisting of the processes.

Zygospore roughly globose, somewhat angular, with numerous short, much branched spines.

Length 25–65 μ ; breadth, including processes, 33–75 μ; breadth of isthmus 7–12 μ ; diam. zygosp., without appendages, 27–37 μ ; including appendages, 50–80 μ.

England.—Cumberland ! Westmoreland ! (*Ralfs*). Lancashire ! W., N., and E. Yorks ! Leicester (*Roy*). Burnham Beeches, Bucks ! Gloucester (*Ralfs*). Surrey ! Sussex (*Ralfs*). Hants ! Dartmoor, Devon (*Harris*). Cornwall !

Wales.—Llyn Padarn !, Snowdon !, Capel Curig ! (*Cooke & Wills*), Llyn-y-cwm-ffynon !, Llyn Gwynant ! and Bettws-y-coed (*Roy*), Carnarvonshire. Dolgelly, Merioneth (*Ralfs*).

Scotland.—General (*Roy & Biss.*).

Ireland.—Donegal ! Clare Isle, Mayo ! Kerry ! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Galicia and Austria. Italy. Norway. Sweden. Denmark. Finland. United States.

St. controversum is closely allied to *St. aculeatum*, from which it differs in its relatively smaller size and its more strongly developed and incurved processes, which are usually bent, giving the specimens a very distorted appearance. It is a very variable species, and the lateral series of spines is not always present, but the dorsal row is usually very strongly developed.

[illegible] Staurastrum cosmospinosum (Börg.) West.

[illegible]

[illegible]

[illegible]

[illegible] Staurastrum [illegible] [illegible]

[illegible]

[illegible]

Var. spinulosum [illegible]

[illegible]

ENGLAND.—Thursley Common, Surrey !

SCOTLAND.—Upper Powlair in Birse, Aberdeen ; pool by the Spital Burn, Strachan, Kincardine (*Roy & Biss.*).

Geogr. Distribution.—Austria. Scandinavia.

156. **Staurastrum Sebaldi** Reinsch.

(Pl. CXLVIII, figs. 5, 6.)

Staurastrum Sebaldi Reinsch, Spec. Gen. Alg. 1867, p. 133, t. 24 D, f. 1–3; Nordst. Norges Desm. 1873, p. 33; Wolle, Desm. U. S. 1884, p. 138, t. 46, f. 1–6; Cooke, Brit. Desm. 1887, p. 176; Börg. Bornh. Desm. 1889, p. 148; De Toni, Syll. Alg. 1889, p. 1220; West, Desm. Massach. 1889, p. 20, t. 3, f. 17; Alg. W. Ireland, 1892, p. 184; Eichler, Mat. Flor. Miedz. 1894, p. 62; West & G. S. West, Some N. Amer. Desm. 1896, p. 267, t. 18, f. 2, 3; Börg. Alg. Faeroes, 1901, p. 234.

Didymidium (Staurastrum) Sancti Sebaldi Reinsch, Algenfl. Frank. 1867, p. 175, t. 11, f. 1.

Cells large, body of cell about $1\frac{1}{2}$ times longer than broad, not including the processes, moderately constricted ; sinus acute, opening widely ; semicells cup-shaped, dorsal margin convex, angles produced to form short, stout, tapering processes, which are usually slightly converging and are tipped with 3 or 4 spines ; processes with several concentric series of strong denticulations ; apex of semicell with a row of large, simple, or 2–4-dentate spines, and usually with a further row of simple spines just beneath the apex, the lower series, however, variable both in size and in character, sometimes even wanting. Vertical view triangular, sides nearly straight, sometimes a little convex, angles slightly produced into short denticulate processes, with a series of simple or complex spines within each lateral margin, which may itself be spinous or not, according as the lower series of spines is present or absent.

Zygospore unknown.

Length 73–85 μ ; breadth, including processes, 69–100 μ ; breadth of isthmus, about 24 μ.

ENGLAND.—Bowness, Westmoreland ! Strensall !, Gormire (*W. B. Turn.*), and Pilmoor !, N. Yorks. Malham Tarn, W. Yorks !

WALES.—Capel Curig ! (*Cooke & Wills*).

SCOTLAND.—Locality ?

IRELAND.—Near Oughterard, Galway ! Mayo and Clare Island ! Carrantuohill, Kerry ! Dublin and Wicklow (*Arch.*). Near R. Blackwater, and south of Lough Neagh, Armagh !

Geogr. Distribution.—Germany. Galicia in Austria. Hungary. Servia. Turkey. Norway. Sweden. Bornholm. Finland. Poland. Faeroes. Iceland (form). Greenland. Siberia (var.). India. Burma (form). Australia. New Zealand (form). United States. Brazil. (var.)

Unfortunately neither specimens nor good drawings of *St. Sebaldi* Reinsch could be obtained for the purpose of the present work, and apparently the figures reproduced on Pl. CXLVIII are not exactly typical. The vertical view is from a drawing by Professor West of an American example, whilst Pl. CXLVIII, fig. 5 was drawn by the present writer from a mounted preparation of Scottish specimens in the British Museum. West & G. S. West ('Alg. Burma,' 1907, p. 221, t. 16, f. 9) give some account of *St. Sebaldi*, and it is evident from a study of their remarks that Pl. CXLVIII, figs. 5 and 6, should both be considered atypical in the fact that they lack a lower row of stout spines beneath the apical row of emarginate spinous processes. In the vertical view therefore the lateral margins should be typically spinous and not smooth. The general form of the specimen on Pl. CXLVIII, fig. 5 is quite typical, and it is stated by the Wests (*loc. cit.*) that the lower row of spines is variable both in size and character. Their apparent variability may account for their absence in the figures given. It is interesting to note that Reinsch ('Contr. Alg. Fung.' 1875, t. ix, f. 4) also figures an individual in which the lateral margins are smooth in the end view, showing the absence of the lower series of spines.

Var. **ornatum** Nordst. (Pl. CXLVIII, fig. 7.)

St. Sebaldi var. *ornatum* Nordst. Norges Desm. 1873, p. 34, t. 1, f. 15; Cooke, Brit. Desm. 1887, p. 176, t. 61, f. 1; De Toni, Syll. Alg. 1889, p. 1220; Turn. Alg. East India, 1893, p. 132; Roy & Biss. Scott. Desm. 1893, p. 25; Schmidle, Beitr. Algenfl. des Schwarzwald u. Oberrheins, VI, 1897, p. 23; West & G. S. West, Alga-fl. Yorks. 1902, p. 106; Alg. N. Ireland, 1902, p. 56; Borge, Botan. Notiser, 1913, p. 50.

St. Sebaldi var. Cooke, in Grevillea, 1881, p. 92, t. 139, f. 5.
St. Sebaldi var. *Cookeii* Gutw. Wahr. d. Priorität, 1890, p. 72; Flor. Glon. Okolic Lwowa, 1891, p. 69.

Cells relatively more slender than in the type; processes much longer and more graceful, nearly parallel; semicells often with a group of verrucæ near the sinus at the base of each process.

Length 50–81 μ; breadth, including the processes, 88–132 μ; breadth of isthmus 15–22 μ.

ENGLAND.—Pilmoor, N. Yorks!

WALES.—Capel Curig! (*Cooke & Wills*) and Llyn-y-cwm-ffynon, Carnarvonshire! In the plankton!

SCOTLAND.—Falls of Rogie, Ross; Brimmond, Slewdrum, Aboyne, Powlair, near Dinnett, Tomacher, Aberdeen; Cammie, Kincardine; Dirdie Moor, Perth (*Roy & Biss.*). New Galloway, Kirkcudbright!

IRELAND.—Mayo! Galway, and in the plankton! Plankton of Lough Neagh!

Geogr. Distribution.—Germany. Norway. Sweden. Finland. Australia. New Zealand.

St. Sebaldi var. *ornatum* is very similar in many ways to *St. Manfeldtii* Delp. Its processes are, however, longer and more graceful, and its granulation somewhat stronger.

Var. **productum** W. & G. S. West. (Pl. CXLIX, fig. 17.)

St. Sebaldi var. *productum* West & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, p. 504, t. 7, f. 24; Compar. Study Plankton Irish Lakes, 1906, p. 86.

Apex of semicell very slightly convex and quite smooth, except for a series of about 6 emarginate verrucæ just within the margin; angles produced to form long verrucose processes; vertical view triangular, sides nearly straight and smooth, with a series of emarginate verrucæ within each lateral margin; angles produced into long verrucose processes.

Length 83 μ; breadth, including processes, 108–115 μ; breadth of isthmus 20 μ.

SCOTLAND.—Plankton of Lochs Fadaghoda and an Sgath, Lewis, Outer Hebrides.

IRELAND.—Plankton of Galway !

Geogr. Distribution.—Finland.

Grönblad ('Desm. Keuru,' 1920, p. 76) has suggested making var. *productum* a distinct species, including in it *St. Traunsteineri* Hustedt ('Desm. Bacil. Tirol.' 1911, p. 340), which he considers to be merely a form of West's alga.

157. **Staurastrum oxyacanthum** Arch.

(Pl. CXLIII, figs. 18, 19.)

St. oxyacanthum Arch. in Quart. Journ. Micr. Sci. 1860, p. 757, t. 7, f. 1, 2 ; in Pritch. Inf. 1861, p. 742 ; Rabenh. Krypt. Flor. Sachs. 1863, p. 193 ; Flor. Europ. Alg. 1868, p. 219 ; Arch. in Quart. Journ. Micr. Sci. 1872, p. 89 ; Cooke, Brit. Desm. 1887, p. 175, t. 60, f. 4 ; Börg. Bornholm. Desm.-fl. 1889, p. 147 ; De Toni, Syll. Alg. 1889, p. 1219 ; Heimerl, Desm. alp. 1891, p. 607 ; West, Alg. W. Ireland, 1892, p. 184 ; Alg. Eng. Lake Distr. 1892, p. 20 ; Roy & Biss. Scott. Desm. 1893, p. 23 ; West & G. S. West, Alg. S. England, 1897, p. 496 ; Alga-fl. Yorks. 1902, p. 106 ; Hustedt, Desm. Bacill. Tirol, 1911, p. 340 ; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 203.

St. scorpioideum var. *brevis* Gutw. Wahr. d. Priorität, 1890, p. 72.

Cells small, about $1\frac{1}{3}$ times broader than long, including the processes, deeply constricted, sinus acute, approximately rectangular ; semicells short, subfusiform or subcuneate, dorsal margin slightly convex, ventral margin very tumid, semicells produced at the angles to form long slender processes, very slightly converging, tipped with about 3 minute spines and with 3 or 4 concentric series of minute denticulations ; apex of semicell armed at the origin of each process with a pair of fairly long spreading spines. Vertical view 2–4- (usually 3-) angled, sides straight and smooth, with a pair of stout spines projecting from just within each margin, angles produced to form denticulate processes. Chloroplast axile, with a central pyrenoid in each semicell, and a pair of plates projecting into each angle.

Zygospore unknown.

Length 26–29 μ ; breadth, including processes, 36–40 μ; breadth of isthmus 9·6–10 μ.

ENGLAND.—Loughrigg !, and near Bowness (*Bissett*),

Westmoreland. Cocket Moss, near Giggleswick and Austwick Moss, W. Yorks! Riccall Common, E. Yorks! Thursley Common, Surrey!

WALES.—Bethesda and Capel Curig, Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Argyle, and Arran (*Roy & Biss.*).

IRELAND.—Donegal! Galway! Kerry! Sugar Loaf Mountain, Cork (*Arch.*) Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—Germany. Switzerland. Austria. Sweden. Bornholm. Finland. Poland (var.). N. Russia. Faeroes. Greenland. Siberia. Mongolia. Patagonia (var.).

The characteristic spines and slightly incurved processes distinguish this species from all others. It is a frequent Desmid in the western areas of the British Isles, although rarely seen outside those districts. Archer reports the occurrence of different combinations of 2, 3 or 4-radiate forms in the same individual.

Var. **polyacanthum** Nordst. (Pl. CXLIII, figs. 20–22.)

St. oxyacanthum var. *polyacanthum* Nordst. Desm. Grönland, 1885, p. 11, t. 7, f. 9; De Toni, Syll. Alg. 1889, p. 1219; Anders. Sverig. Chloroph. 1890, p. 12; Lütkem. Desm. Millstättersees, 1900, p. 23.

Cells similar in form to the type, but larger, and with slightly longer and rather more slender processes; semicells in front view with a number of scattered spines just beneath the apex, sometimes occurring in two horizontal series; body of semicell with 2 or 3 short series of granules under each process. Vertical view usually triangular, sides straight with about 2 parallel marginal series of spines, spines numerous and sometimes scattered; basal view of semicell with several short concentric series of granules extending from the denticulations of the processes to the isthmus, the innermost series being larger and forming a concrescent verruca.

Length 41–48 μ; breadth, including processes, 59–68 μ; breadth of isthmus 11–13 μ.

ENGLAND.—Austwick Moss, W. Yorks (*N.C.*).

WALES.—Llyn Ogwen, Carnarvonshire!

Geogr. Distribution.—Austria. Sweden. Greenland.

158. **Staurastrum dorsidentiferum** W. & G. S. West.

(Pl. CXLVIII, fig. 4.)

Staurastrum dorsidentiferum West & G. S. West, Comp. Study Plankton Irish Lakes, 1906, p. 103, t. 11, f. 10; British Freshw. Phytoplankton, 1909, p. 202.

Cells large, about $1\frac{1}{2}$ times broader than long, including the processes, constriction fairly deep, sinus open and obtuse at the apex; semicells smooth and cup-shaped, apex generally flattened and gently undulate, angles produced to form long stout processes projecting nearly horizontally, and tipped with 4 teeth; lower margin of each process crenulate, upper margin also crenulate, but the median 3–6 (usually 5) crenations bearing acute, erect teeth; vertical view triangular, sides slightly convex, angles produced to form long processes, with undulate margins, and a single row of spines along each.

Zygospore unknown.

Greatest length 75–79 μ; breadth, without processes, about 48 μ; with processes, 108–120 μ; breadth of isthmus 18 μ.

Ireland.—Plankton of Loughs Conn and Cullin, Mayo! Lough Corrib, Galway!

The direction of the processes in the front view is somewhat variable. In some specimens they are rather upwardly divergent, but in the majority they are horizontally disposed. The number of teeth affixed to the crenations of the upper margins of the processes is also variable, even on the processes of the same plant. The species is confined to plankton and should be compared with *St. gracile* Ralfs and *St. Sebaldi* Reinsch. Its large cells, smooth except for the row of stout spines on the top of each process, distinguish it from all other species.

159. **Staurastrum aciculiferum** (West) Anders.

(Pl. CXXXIV, fig. 6.)

St. Avicula var. *aciculiferum* West, Add. Alg. W. Yorks. 1889, p. 293, t. 291, f. 12; Alg. N. Wales, 1890, p. 16.

St. aciculiferum Anders. Sverig. Chlor. 1890, p. 11, t. 1, f. 4; West & G. S. West, Alga-fl. Yorks. 1902, p. 98; Alg. N. Ireland, 1902, p. 47; Borge, Beiträge Alg. Schweden, 1906, p. 45.

Cells small, about as long as broad, including the processes, deeply constricted, sinus widely open; semicells elliptical, dorsal margin only slightly convex, ventral margin more strongly so; semicells produced at the angles to form short solid processes deeply bifid at the apex, the two teeth lying in the same vertical plane; with two accessory spines (also occasionally bifid), projecting almost vertically from the apex between each pair of angles. Vertical view triangular, sides very slightly convex, angles broadly rounded and then slightly produced into a short solid process, with a pair of simple or bifid spines projecting from the apex across each lateral margin. Cell-wall with about 2 obscure series of minute granules round each angle.

Zygospore unknown.

Length 21–30 μ; breadth 22–34 μ; breadth of isthmus 5–9 μ.

England.—Helvellyn, Westmoreland! Cocket Moss, near Giggleswick; Penyghent; Whernside; Mossdale Moor, Widdale Fell, W. Yorks! Mickle Fell and Lund's Fell, N. Yorks!

Wales.—Moel Siabod, bog between Glyder Fach and Llugwy, y Foel Fras, and Tal-y-fan, Carnarvonshire! Ffestiniog, Merioneth!

Scotland.—Hoy, Orkneys!

Ireland.—Near Gweedore, Donegal! Achill Island and Clare Island, Co. Mayo! Boggy inlet of Lough Neagh.

Geogr. Distribution.—Sweden. United States.

St. aciculiferum really has very little affinity with any other species of Section I, but strictly speaking it belongs here. It was originally described as a variety of *St. Avicula*, but whereas the angular spines of this species are attached separately to the "body" of the semicell, in *St. aciculiferum* there is a distinct though short solid process, deeply bifid at its apex. The apical spines may be considered well developed denticulations of the series of small granules round the angles; they are very often bifid.

SECTION J.

Semicells with accessory processes, mostly of dorsal origin.

* Processes quite smooth.

† All the processes short, less than half the diameter of the "body" of the cell in length.

160. *St. furcatum.*
161. *St. senarium.*
162. *St. gemelliparum.*

†† Processes longer, nearly as long as the body of the cell is broad, and frequently longer.

163. *St. Clevei.*
164. *St. Tohopekaligense.*

** Processes rough with granules or denticulations.

† At least the dorsal processes short, and angular processes never attaining very great length.

165. *St. arcuatum.*
166. *St. subavicula.*
167. *St. amphidoxon.*
168. *St. megalonotum.*
169. *St. monticulosum.*
170. *St. diplacanthum.*
171. *St. Westii.*
161. *St. senarium.*
172. *St. forficulatum.*
173. *St. furcigerum.*

†† All the processes of considerable length.

174. *St. Arctiscon.*
175. *St. sexangulare.*

160. **Staurastrum furcatum** (Ehr.) Bréb.

(Pl. CLV, figs. 1–4.)

Xanthidium furcatum Ehr. Inf. 1838, p. 148, t. 10, f. 25; Menegh. Synops. Desm. 1840, p. 224; Ralfs, Brit. Desm. 1848, p. 213.
? *X. Ehrenbergii* Corda, Alm. de Carlsbad, 1840, p. 214, t. 5, f. 36, 37.
Staurastrum spinosum Ralfs, Brit. Desm. 1848, p. 143, t. 22, f. 8; De Bary, Conj. 1858, p. 44; Reinsch, Contrib. Alg. et Fung. 1875, p. 90, t. 10, f. 3; Heimerl, Desm. Alp. 1891, p. 607.
Phycastrum (*Pachyactinium*) *Ehrenbergianum* Näg. Gatt. einz. Alg. 1849, p. 128.
Asteroxanthium furcatum Kütz. Spec. Alg. 1849, p. 183.
Staurastrum furcatum Bréb. Liste Desm. 1856, p. 136; Arch. in Pritch. Infus. 1861, p. 743; Rabenhorst, Flor. Europ. Alg. 1868, p. 218 (in part); Nordst. Norges Desm. 1873, p. 33; Kirchn. Alg. Schles. 1878, p. 170; Wolle, Desm. U. S. 1884, p. 150, t. 40, f. 40, 41; Cooke, Brit. Desm. 1887, p. 146; De Toni, Syll. Alg. 1889, p. 1153; West, Alg. N. Wales, 1890, p. 16, f. 11; Alg. W. Ireland, 1892, p. 174; Alg. Engl. Lake Distr. 1892, p. 19; Roy & Biss. Scott. Desm. 1893, p. 20; Lütkem. Desm. Attersees,

1893, p. 563; West & G. S. West, Alg. S. England, 1897, p. 493; Comère, Desm. de France, 1901, p. 165, t. 13, f. 21; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 203.
Didymidium (Staurastrum) spinosum Reinsch, Alg. Frank. 1867, p. 168.
Staurastrum furcatum var. *armigerum* Cooke, Brit. Desm. 1887, p. 146, t. 51, f. 1.
St. cornubiense Benn. Alg. N. Cornwall, 1887, p. 11, t. 4, f. 24.
St. De Tonii Eichler & Gutw. Nonn. Spec. alg. nov. 1894, p. 18, t. 5, f. 51.

Cells small, about as long as broad (including the processes), or sometimes slightly longer or shorter than broad, deeply constricted, sinus acute and open; semicells subelliptical or subglobose, dorsal and ventral margins almost equally convex, lateral angles produced to form short, stout, nearly horizontal processes, with bifid apices, the two teeth lying in the same vertical plane; apical margin of each face of the semicell with two short bifid processes, which are nearly erect; cell-wall smooth, or very minutely punctate. Vertical view triangular, angles scarcely produced, ending in a spine, sides straight or very slightly concave, with 2 short bifid processes projecting from each lateral margin.

Zygospore globose, with numerous spines bifid at the apex (*Ralfs*).

Length, including processes, 25–33 μ; breadth, including processes, 20–40 μ; breadth of isthmus 6–10 μ; diam. zygosp., without processes, 33 μ; including processes 57·5 μ.

ENGLAND.—Cumberland! Westmoreland! Strensall Common! (*W. B. Turner*) and Pilmoor! N. Yorks! Leicestershire (*Roy*). Warwicks (*Wills*). Surrey! (*Ralfs*). Dartmoor, Devon (*Harris*). Cornwall!

WALES.—Fairly general! (at 2200 feet on Glyder Fach). In the plankton!

SCOTLAND.—General! (*Roy & Biss.*). In the plankton!

IRELAND. — Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Turkey. Norway. Sweden. Denmark. Bornholm. Finland. Poland. N. and S. Russia. Iceland. Japan. India. Australia. United States.

Cooke ('Brit. Desm.' 1887, p. 147, t. 53, f. 6) figures a Desmid which he attributes to *St. furcatum* var. *candianum* (Delp.) Cooke (see Pl. CLV, fig. 5). Cooke's figure, however, shows granulations round the lateral angles, which would indicate greater affinity with *St. subavicula* West than with *St. furcatum*. There is no indication of granulation in *St. candianum* Delp. ('Desm. subalp.' 1877, p. 140, t. 11, f. 22–24; see Pl. CLV, fig. 6). Harris ('Desm. Dartmoor,' 1917, p. 29) has also recorded *St. furcatum* var. *candianum* (Delp.) Cooke. It is probable that this, too, would have been better referred to *St. subavicula* West.

Var. **subsenarium** W. & G. S. West. (Pl. CLV, fig. 7.)

St. furcatum var. *subsenarium* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 10, f. 53; Alg. S. England, 1897, p. 493; Grönblad, Desm. Keuru, 1920, p. 65, t. 3, f. 52, 53.

This variety has a simple spine beneath each dorsal process.

Length, without processes, 20–29 μ; breadth, including processes, 25–39 μ; without processes, 18–32·5 μ; breadth of isthmus 8–9·5 μ.

England.—Scandale, Westmoreland! Dartmoor, Devon!

Wales.—Llyn Idwal (*N. C.*).

Ireland.—Leenane to Westport, Mayo!

Geogr. Distribution.—Finland.

This variety differs from the typical form in the possession of concentric series of granules round the angles of the semicell as well as in the additional spines.

161. **Staurastrum senarium** (Ehr.) Ralfs. (Pl. CLVI, fig. 3.)

Desmidium senarium Ehr. Micr. Leb. S. & N. Amer. 1843, p. 412, t. 4, f. 22.
Staurastrum senarium Ralfs, Brit. Desm. 1848, p. 216; Arch. in Pritch. Inf. 1861, p. 742, t. 2, f. 7; Rabenh. Flor. Europ. Alg. 1868, p. 220; Lund. Desm. Suec. 1871, p. 66; Nordst. Desm. Spetsb. 1872, p. 41; Wolle, Desm. U. S. 1884, p. 147, t. 52, f. 1; De Toni, Syll. Alg. 1889, p. 1155; Turn. Alg. E. India, 1893, p. 119, t. 15, f. 13; G. S. West, Alg. Yan Yean, 1909, p. 68, t. 6, f. 13; Alg. Colombia, 1912, p. 1045.
Stephanoxanthium senarium Kütz. Spec. Alg. 1849, p. 184.
Staurastrum furcatum var. *senarium* Joshua, Desm. Burma, 1886, p. 643.

Cells small, about $1\frac{1}{3}$ times broader than long, deeply constricted, sinus acute and open; semicells elliptical

or subfusiform, lateral angles gradually produced into short processes with bifid spreading apices; with two accessory processes on the faces of the semicell between each two consecutive angular processes and in the same horizontal plane with them, and with two other processes projecting from the apical margin of each face immediately above the accessory processes of the lower whorl; processes smooth, or the angular ones sometimes with a circle of minute denticulations. Vertical view triangular, angles very slightly produced; sides gently concave, each with 2 bifid processes projecting from its margin, and with 2 others just within the margin on the apex.

Zygospore unknown.

Length 42–46 μ; breadth, including processes, 46–58 μ; breadth of isthmus 11–15 μ.

ENGLAND.—Bowness, Westmoreland!

IRELAND.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Sweden. Bornholm. Finland. Poland. Spitzbergen (form). India. Burma. Australia. United States. Colombia.

St. senarium is closely allied to *St. furcatum* Ehr., from which it differs in the possession of 15 processes, instead of 9. The processes are arranged one at each angle, with 6 others in the same plane as these 3 angular ones, and a dorsal series of 6 on the apex. The presence of denticulations on the angular processes is of little importance, since they are sometimes present in one semicell of an individual and absent from the other.

162. **Staurastrum gemelliparum** Nordst.

(Pl. CLVI, fig. 5.)

Staurastrum gemelliparum Nordst. Desm. Brasil, 1869, p. 230, t. 4, f. 54; Wille, Sydamerik. Alg.-fl. 1884, p. 21; De Toni, Syll. Alg. 1889, p. 1175; West & G. S. West, Alg. Ceylon, 1902, p. 179, t. 21, f. 25; Borge, Sao Paulo Alg. 1918, p. 54, t. 4, f. 25.

Cells small, about as long as broad, or a little longer, deeply constricted, sinus open and acute; semicells subelliptical, dorsal margin nearly straight, ventral

margin more convex; each angle of the cell with 4 processes, an upper pair and a lower pair, processes bifid at the apex, the two teeth lying in the same vertical plane. Vertical view triangular, sides slightly concave, angles broadly truncate and bifid, a lower pair of short processes visible under an upper pair at each angle. Cell-wall smooth or minutely punctate.

Zygospore unknown.

Length, without processes, 17–25 μ; including processes, 26–30 μ; breadth, including processes, 20–26 μ; breadth of isthmus 7·7–10 μ.

SCOTLAND.—Glen Shee, Perth!

Geogr. Distribution.—Poland (form). Ceylon. United States. Colombia (form). Brazil.

This species should be compared with *St. quadrangulare* Bréb., which differs in the possession of four *solid* spines at each angle.

163. **Staurastrum Clevei** (Wittr.) Roy & Biss.

(Pl. CLVI, fig. 6.)

Staurastrum læve Cleve, Sverig. Desm. 1863, p. 490.
St. læve var. *Clevei* Wittr. Skand. Desm. 1869, p. 18, t. 1, f. 9; Arch. in Quart. Journ. Micr. Sci. vol. ii, 1871, p. 92; Cooke, Brit. Desm. 1887, p. 180, t. 63, f. 3; Eichler, Mat. Flor. Miedz. 1894, p. 62.
St. Kitchellii Wolle, Desm. U. S. 1884, p. 150, t. 40, f. 35, 36; De Toni, Syll. Alg. 1889, p. 1155; West & G. S. West, Desm. U. S. 1898, p. 319, t. 18, f. 10, 11.
St. Clevei Roy & Biss. Scott. Desm. 1893, p. 18; Wittr. & Nordst. Alg. Exs. fasc. 35, 1903, p. 12; West & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, p. 503; Brit. Freshw. Phytoplankton, 1909, p. 202.

Cells rather under medium size, slightly longer than broad, excluding the processes, deeply constricted, sinus acute and open; semicells subelliptic, lower margin strongly ventricose, dorsal margin slightly convex, lateral angles gradually produced to form fairly long processes, deeply bifid with spreading apices in the same vertical plane; each face of the semicell with another process, inserted obliquely near to each angular process. Vertical view triangular, angles produced to form processes, sides slightly convex, apex with an accessory

process projecting obliquely across each lateral margin near the angle. Cell-wall smooth.

Zygospore unknown.

Length, without processes, 30–32 μ; including processes, 52–61 μ; breadth, including processes, 50–57 μ; breadth of isthmus 11·5–17 μ.

SCOTLAND.—Brin, and in Skye, near Loch Cornisk, Inverness; Glen Coe, Argyle (*Roy & Biss.*). Rhiconich, Sutherland! Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

IRELAND.—Kylemore, Co. Galway (*Arch.*).

Geogr. Distribution.—Norway. Sweden. Finland. United States.

164. **Staurastrum Tohopekaligense** Wolle.

(Pl. CLV, fig. 12.)

Staurastrum Tohopekaligense Wolle, in Bull. Torr. Bot. Club. 1885, p. 128, t. 51, f. 4, 5; Freshw. Alg. U. S. 1887, p. 45, t. 59, f. 4, 5; De Toni, Syll. Alg. 1889, p. 1162; West & G. S. West, Alg. Ceylon, 1902, p. 180; Alg. Third Tanganyika Exp. 1907, p. 130, t. 3, f. 15.

Cells large, about $1\frac{1}{2}$ times longer than broad, without the processes, deeply constricted, sinus acute, narrow at first, then opening widely; semicells broadly oval or subglobose, lateral angles produced to form long slender processes usually with bifurcate spreading apices; often with 2 other similar processes between each pair of angular processes; with a further dorsal series of processes, two of which project between each pair of consecutive angles. Vertical view triangular or quadrangular, sides straight or very slightly concave or convex, angles produced into long slender processes, with a pair of dorsal processes projecting from each lateral margin, and frequently with a pair of processes also on the same plane as the angular processes beneath the dorsal series.

Zygospore unknown.

Length, without processes, 29–51 μ; with processes, 48–91 μ; breadth, without processes, 23–40 μ; with processes, 46–96 μ; breadth of isthmus 13–19 μ.

Geogr. Distribution.—Finland. India. Central Africa. United States.

This species exhibits a certain amount of variation in size, in the form of the body, and in the length of the processes. There are two whorls of processes on each semicell, the lower whorl consisting (in the triradiate form) either of 3 processes (one at each angle), or of 9 processes (one at each angle and a pair on each lateral margin), and the upper whorl consisting of 6 processes. Thus the total number of processes on each semicell is either 9 or 15 in the triradiate form. Each process is very slightly dilated at the end, and is usually bifurcate, occasionally trifurcate, and the lobes are hollow to the tip.

Var. **trifurcatum** W. & G. S. West. (Pl. CLV, figs. 13, 14.)

St. Tohopekaligense var. *trifurcatum* West & G. S. West, Alg. Madagas. 1895, p. 80, t. 9, f. 8; Alg. Ceylon, 1902, p. 181, t. 21, f. 27; Further Contrib. Plankton Scott. Lochs, 1905, p. 503, t. 7, f. 7.

This variety is characterised by its slightly shorter processes, with strong trifid spreading apices; processes usually 3 at each angle, less spreading in the front view. Chloroplast axile with a central pyrenoid.

Length, without processes, 36–45 μ; including processes, 54–75 μ; breadth, without processes, 27–32 μ; including processes, 50–70 μ; breadth of isthmus 9·5–14 μ.

SCOTLAND.—Rhiconich, Sutherland! Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Geogr. Distribution.—Ceylon. Australia. Madagascar.

This variety, like the type, exhibits considerable variation. The British examples had always the smaller number of processes in the lower whorl, *i. e.* 3 in the triangular form and 4 in the quadrangular form, but specimens from Ceylon have been seen in which there were 9 lower processes in a triangular specimen. The trifid apices of the processes are not constant either, for in the specimens from Loch Fadaghoda the processes of the upper whorl were frequently bifid.

165. **Staurastrum arcuatum** Nordst.

(Pl. CLV, fig. 8.)

Staurastrum arcuatum Nordst. Norges Desm. 1873, p. 36, t. 1, f. 18; Cooke, Brit. Desm. 1887, p. 169, t. 51, f. 2; Boldt, Desm. Grönland, 1888, p. 40; De Toni, Syll. Alg. 1889, p. 1207; West, Freshw. Alg. Maine, II, 1891, p. 4, t. 15, f. 13; Alg. W. Ireland, 1892, p. 181; Turner, Alg. E. India, 1893, p. 120, t. 14, f. 20; Roy & Biss. Scott. Desm. 1893, p. 17; West & G. S. West, Alg. S. England, 1897, p. 493; Lütkem. Desm. Millstättersees, 1900, p. 19; Comère, Desm. de France, 1901, p. 156, t. 11, f. 16; Bohlin, Flor. alg. d'Açores, 1901, p. 64, t. 1, f. 26; Cushman in Bull. Torr. Bot. Club, 1907, p. 164.

Cells small, about $1\frac{1}{2}$ times broader than long, deeply constricted, sinus acute and opening widely; semicells elliptical, diverging or externally lunate, angles slightly produced, ending in two stout diverging spines which lie in the same vertical plane; dorsal margin straight, ventral margin convex, cell-wall rough with granules arranged in concentric series round the angles. Vertical view triangular, sides concave, angles produced and tapering, with a pair of small bifid processes at the base of each; cell-wall smooth in the centre.

Zygospore unknown.

Length, without processes, 20 μ; breadth, without processes, 29 μ; including processes, 32 μ; breadth of isthmus 9 μ.

ENGLAND. — Brandreth, Westmoreland! Epping Forest, Essex! New Forest, Hants! Gunwen Moor, Cornwall!

SCOTLAND.—Pool beside Loch Dawan, Dalbagie, and in Glen Clunie, Aberdeen (*Roy & Biss.*).

IRELAND.—Lakes east of Lough Bofin, Galway! Near Lough Brin, Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Austria. Servia. Greenland. Central China (var.). Japan. India. Azores. United States. Colombia.

Var. **Guitanense** West. (Pl. CLV, fig. 9.)

St. arcuatum var. *Guitanense* West, Alg. W. Ireland, 1892, p. 181, t. 23, f. 10.

Differs from the type in its relatively greater length and broader isthmus, angles produced into shorter

processes, with more delicate spines, dorsal processes shorter.

Length, without processes, 25 μ; breadth, including spines, 40 μ; breadth of isthmus 14 μ.

IRELAND.—Lough Guitane, Kerry!

166. **Staurastrum subavicula** W. & G. S. West.

(Pl. CLV, fig. 10.)

St. arcuatum var. *subavicula* West, Alg. Engl. Lake Distr. 1892, p. 20, f. 25.
St. subavicula West & G. S. West, New Brit. Alg. 1894, p. 12.
St. arcuatum var. *vastum* Schmidle, Alg. Bern. Alps, 1894, p. 94, t. 6, f. 7.
St. vastum Schmidle, Beitr. Alp. Alg. 1896, p. 31.

Cells about as long as broad, or a little longer, including the processes, deeply constricted, sinus open, almost rectangular; semicells subelliptical, or cuneate, apex and lateral margins nearly straight or slightly convex; upper angles scarcely produced, ending in two spines, and with two series of granules just beneath, apex of each face with a pair of short bifid processes. Vertical view triangular, sides concave, angles rounded with two spines, one beneath the other, apex with a circle of 6 bifurcate processes; centre of apex smooth.

Zygospore unknown.

Length 32 μ; breadth 32–32·5 μ; breadth of isthmus 9·5 μ.

ENGLAND.—Harrop Tarn, Westmoreland!

WALES.—Glyder Fawr, Carnarvonshire!

Geogr. Distribution.—Germany. Australia.

167. **Staurastrum amphidoxon** West.

(Pl. CLV, fig. 11.)

Staurastrum amphidoxon West & G. S. West, New Brit. Freshw. Alg. 1894, p. 10, t. 1, f. 17.

Cells small, nearly twice as broad as long, deeply constricted; semicells subelliptical, rough with granules arranged in concentric series round the angles, apex nearly straight, ventral margin convex, angles produced

into short processes with 3 tiny spines at their apex. Vertical view triangular, sides concave, and with two short diverging processes with bifid apices at the base of each angular process.

Zygospore unknown.

Length, 22·5 μ; breadth, including processes, 39 μ; breadth of isthmus 13·5 μ.

Scotland.—New Galloway, Kirkcudbright!

Geogr. Distribution.—W. Greenland (var.).

This species seems to be very closely allied to *St. arcuatum* Nordst. Its lateral angles are, however, not so divergent as in that species, nor are the apical processes so long or erect. In the vertical view the angles are also distinctly inflated in *St. arcuatum*, whereas in *St. amphidoxon* the body of the cell gradually tapers at the angles into the processes.

168. **Staurastrum megalonotum** Nordst.

(Pl. CLIV, fig. 13.)

Staurastrum megalonotum Nordst. Desm. Arctoæ, 1875, p. 35, t. 8, f. 38; Boldt, Desm. Grön. 1888, p. 39; De Toni, Syll. Alg. 1889, p. 1222; Cushman in Rhodora, 1905, p. 263.

Cells of medium size, nearly as long as broad, deeply constricted, sinus open and acute; semicells in front view subhexagonal fusiform, apex somewhat produced, truncate or slightly concave, upper angles ending in a spine, lateral angles produced slightly and also ending in a spine, upper margin of lateral angles gently concave, lower margins nearly straight; angles provided with several series of denticulations. Vertical view quadrangular, sides concave, angles slightly produced, ending in a spine, and with concentric acute denticulations, lateral margins with acute granules near the angles, but smooth in the median part, with two spines or spinulose processes just within each lateral margin; centre of apex smooth.

Zygospore unknown.

Length, without spines, 42–46 μ; breadth, including spines, 62 μ; breadth of isthmus 16–21 μ.

ENGLAND.—? Mickle Fell, N. Yorks !
Geogr. Distribution.—Germany (form). Austria (form). Spitzbergen. Greenland.

This alga is extremely rare in the British Isles. There is only one doubtful record for it from Yorkshire.

169. **Staurastrum monticulosum** Bréb.

(Pl. CLIV, fig. 8.)

Binatella monticulosa Bréb. in Chev. Micr. 1839, p. 272.
Staurastrum monticulosum Bréb. in Menegh. Synops. Desm. 1840, p. 226; Ralfs, Brit. Desm. 1848, p. 130, t. 34, f. 9; Arch. Suppl. Cat. Desm. 1858, p. 257, t. 21, f. 16; in Pritch. Inf. 1861, p. 739; Rabenh. Krypt.-fl. Sachs. 1863, p. 192; Flor. Europ. Alg. 1868, p. 214; Lund. Desm. Suec. 1871, p. 65; Jacobs. Desm. Danemark, 1875, p. 209; Cooke, Brit. Desm. 1887, p. 147, t. 50, f. 10; De Toni, Syll. Alg. 1889, p. 1156; Comère, Desm. de France, 1901, p. 166, t. 12, f. 3; Borge, Botan. Notiser, 1913, p. 50; Grönblad. Desm. Keuru, 1920, p. 87.
Phycastrum monticulosum Kütz. Phyc. Germ. 1845, p. 138.
Stephanoxanthium monticulosum Kütz. Spec. Alg. 1849, p. 184.

Cells rather under medium size, very slightly longer than broad, deeply constricted, sinus open and acute; semicells subtrapeziform, lower lateral margins slightly convex, upper lateral margins distinctly concave, lateral angles truncate with two spines lying in the same vertical plane; apex of semicell straight or slightly concave, with a pair of short conical processes, tipped with spines, at each upper angle of the semicell (usually only 4 of these are visible); angles of semicell with several concentric series of small granules. Vertical view usually triangular, sides straight or very slightly convex, with two spinate projections just within each margin; angles subacute, ending in two spines (one above the other), and with several series of granules.

Zygospore unknown.

Length, including spines, 40–57 μ; breadth, including spines, 35–42 μ; breadth of isthmus 13–19 μ.

ENGLAND.—Near Bowness, Westmoreland (*Biss.*). ? Cowgill Wold Moss, Widdale Fell, W. Yorks! Pilmoor, N. Yorks! Penzance, Cornwall (*Ralfs*). Dartmoor (*Harris*).

WALES.—Capel Curig (*Roy*) and Glyder Fawr! Carnarvonshire.

SCOTLAND.—Loch Luichart, Ross (*N. C.*).

IRELAND.—Carrantuohill, Kerry! Dublin and Wicklow (*Arch.*). Clare Island, Mayo!

Geogr. Distribution.—France. Germany. Austria. Servia. Norway. Sweden. Denmark. Bornholm. Finland. N. Russia. Greenland. Siberia (var.). Japan. United States.

[1] Typical *St. monticulosum* is not a common Desmid in the British Isles, var. *bifarium* Nordst. being much more frequently found. Apparently W. & G. S. West did not thoroughly understand this species, for Pl. CLIV, fig. 11 is a drawing showing their idea of the typical form. This obviously does not belong to *St. monticulosum*, however, and the localities for the species with the Wests' authority (shown!) should consequently not be taken as correct. Pl. CLIV, fig. 8 is a drawing by the present writer from L. Luichart, and it agrees exactly with a drawing of Grönblad ('Act. Soc. Flor. Fauna Fenn.' 47, 1920, p. 90), who has recently examined de Brébisson's original specimens, and gives a good review of the species and its various varieties.

Var. **bifarium** Nordst. (Pl. CLIV, fig. 9.)

St. monticulosum var. *β bifarium* Nordst. Norges Desm. 1873, p. 31, t. 1, f. 14; Wolle, Desm. U. S. 1884, p. 144, t. 51, f. 24–26; De Toni, Syll. Alg. 1889, p. 1157; West & G. S. West, Alg. Madag. 1895, p. 73, t. 8, f. 21; Borge, Botan. Notiser, 1913, p. 50; Grönblad, Desm. Keuru, 1920, p. 89.
St. senarium v. *alpinum* f. *tatrica* Racib. Nonn. Desm. Polon. 1885, p. 32, t. 12, f. 7.
St. senarium var. *bifarium* Kaiser, Alg. Traunst. 1914, p. 153.

Semicells with the apical processes emarginate at the apex, and with an additional series of similar bifid prominences round the middle part of the semicell, two between each pair of angles.

Length, without processes, 29–37 μ; breadth, without processes, 30–34 μ; breadth of isthmus 10–13 μ.

SCOTLAND.—Falls of Connon, Ross; near Ballater, Aberdeen (*Roy & Biss.*). Plankton of Loch Diracleet, Harris, Outer Hebrides!

Geogr. Distribution.—Germany. Norway. Sweden. Finland. Poland. Madagascar. Australia. United States.

Pl. CLIV, fig. 9 is the form of *St. monticulosum* frequently encountered in Britain. It is a form of var. *bifarium* Nordst., but is not identical with Nordstedt's plant, since the lower whorl of processes is very feebly developed, being represented merely by pairs of spines. It resembles in some respects var. *groenlandicum* Grönbl.

Var. **groenlandicum** Grönblad. (Pl. CLIV, fig. 10.)

St. megalonotum forma Nordst. Desm. Groenl. 1885, p. 11, t. 7, f. 7, 8; West, Alg. W. Ireland, 1892, p. 173, t. 23, f. 1.
St. monticulosum Roy & Biss. Scott. Desm. 1893, t. 3, f. 4.
St. monticulosum var. *groenlandicum* Grönblad, Desm. Keuru, 1920, p. 88, t. 1, f. 17, 18.

Very similar to var. *bifarium* Nordst.; apical and lower series of prominences, however, considerably reduced, and provided with one spine each instead of two; vertical view with four slight prominences in each lateral margin apart from the apical processes, the median pair being, however, larger than the outer two; granulation round the angles stronger than in the other forms.

Length, including processes, 46–50 μ; breadth, including processes, 46–50 μ; breadth of isthmus, about 16 μ.

SCOTLAND.—Between Bishop's Dam and Clochnaben, Kincardine.

IRELAND.—Nacoogarrow Lough, Galway! Carrantuohill, Kerry!

Geogr. Distribution.—Greenland. Finland.

Var. **pulchrum** W. & G. S. West. (Pl. CLIV, fig. 12.)

St. monticulosum var. *pulchrum* West & G. S. West, Alg. N. Ireland, 1902, p. 47, t. 2, f. 28; Grönblad, Desm. Keuru, 1920, p. 90.

Smaller and more delicate than the typical form, processes at the angles much more slender, solid, and emarginate at their apices, with a pair of slender and longer spines above each angle.

Length, without spines, 23 μ; including spines, 29 μ; breadth, without spines, 21 μ; including spines, 28 μ; breadth of isthmus 8 μ.

IRELAND.—Lough Gatny, Donegal!

Grönblad ('Desm. Keuru,' 1920, p. 90) suggests that this alga is not correctly placed in *St. monticulosum*—an opinion with which the writer entirely agrees. It is perhaps nearest amongst British Desmids to *St. aciculiferum* (West) Anders., which differs, however, in several respects. It seems to have very little affinity with *St. monticulosum* Bréb.

170. **Staurastrum diplacanthum** De Not.

(Pl. CLVI, fig. 1.)

Staurastrum diplacanthum De Not. Desm. Ital. 1867, p. 49, t. 4, f. 38; Turner, Desm. Notes, 1893, p. 345.
St. vestitum var. *diplacanthum* Rabenh. Flor. Europ. Alg. 1868, p. 219.
St. monticulosum var. *diplacanthum* Nordst. in De Toni, Syll. Alg. 1889, p. 1157.

Cells rather under medium size, slightly longer than broad, deeply constricted, sinus open and acute; semicells broadly fusiform, dorsal and ventral margins almost equally convex: lateral angles very slightly produced and terminating in 3 stout spines; ventral margins with a stout spine about midway between the angles and the isthmus; dorsal margin with a pair of short distant processes, bifid at their apex, and with a pair of simple spines in the middle between them. Vertical view triangular, sides nearly straight, angles tipped with 3 stout spines: lateral margins with a pair of bifid processes, and between these one or two simple spines. Cell-wall irregularly punctate.

Zygospore unknown.

Cells about 40 μ in diameter.

England.—Strensall Common, N. Yorks (*W. B. Turner*).

Geogr. Distribution.—Italy.

Var. **anglicum** Turner. (Pl. CLVI, fig. 2.)

St. diplacanthum var. *anglicum* W. B. Turn. Desm. Notes, 1893, p. 345, f. 10.

Apex of semicell more convex than in the type, with a ring of little verrucæ; cell-wall more spiny than in the typical form.

Length, without spines, 27–32 μ; with spines, 37–41 μ; breadth, without spines, 28 μ; with spines, 34 μ; breadth of isthmus 9–11 μ.

Wales.—Trelleck Common, Monmouth (*Turn.*).

Neither *St. diplacanthum* nor its var. *anglicum* are very well known, and the figures hitherto published have been very poor. It is almost impossible to get any clear idea of them from the figures of De Notaris and Turner.

171. **Staurastrum Westii** Turner.

(Pl. CLVI, fig. 4.)

Staurastrum Westii Turn. Desm. Notes, 1893, p. 345, f. 9.

Each angle of the cell possesses 5 short thick processes arranged in quincunx, *i. e.* one in the centre, and one at each of 4 corners, and in addition there are 3 or 4 spines on the upper margin of each angle (*Turn.*).

Zygospore unknown.

Length, without spines, 25–28 μ; including spines, 28–32 μ; breadth, without spines, 18–21 μ; with spines, 23–26 μ; breadth of isthmus 8–10 μ.

Wales.—Llyn Padarn, Carnarvonshire (*Turn.*).

This species has never been observed since it was described by Turner, and although his description and figure are somewhat meagre, it seems to have very well-defined characters. Turner considered it to be intermediate in form between *St. diplacanthum* De Not. and *St. spongiosum* var. *Griffithsianum*.

172. **Staurastrum forficulatum** Lund.

(Pl. CLIV, figs. 14–16.)

Staurastrum forficulatum Lund. Desm. Suec. 1871, p. 66, t. 4, f. 5; De Toni, Syll. Alg. 1889, p. 1176; Roy & Biss. Scott. Desm. 1893, p. 20; West & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, p. 505, t. 7, f. 17; Brit. Freshw. Phytoplankton, 1909, p. 202; Grönblad, Desm. Keuru, 1920, p. 64.

St. aculeatum var. *bifidum* Schmidle, Lappmark Süsswasseralgen, 1898, p. 55, t. 2, f. 44.

St. forficulatum var. *longispinum* ibid., p. 55, t. 2, f. 42, 43.

Cells of medium size, about as long as broad, a little longer than broad, or even up to $1\frac{1}{3}$ times broader than

long (excluding the spines); deeply constricted, sinus first nearly linear, then opening widely; semicells subtrapeziform or subelliptical, apex truncate with 2 prominent apical emarginate spines or short bifid processes on the upper margin of each face; lateral angles very slightly produced and ending in two stout diverging spines, which lie in the same vertical plane; upper and lower margins of angles with 2 verrucæ or tiny spines; and with 2 emarginate spines or short spinous processes projecting from each face. Vertical view triangular or quadrangular, sides concave with 2 short processes, emarginate at the apex, projecting from each, and with 2 others just within the margin; angles very slightly produced.

Zygospore unknown.

Length, without processes, 40–45 μ; with processes, 48–64 μ; breadth, without spines, 37–60 μ; with spines, 54–95 μ; breadth of isthmus 9–16 μ.

SCOTLAND.—Near Buchanty, and near Fowlis Wester, Perth (*Roy & Biss.*). Rhiconich, Sutherland (*N. C.*). Plankton of Loch Fadaghoda, Lewis, and at Harris, Outer Hebrides!

Geogr. Distribution. — Norway. Sweden. Finland. Australia. United States.

This rare species is confined in the British Isles to the bogs of the older palæozoic and precambrian areas. The biradiate form is known from S. Harris, Outer Hebrides (see Pl. CLIV, fig. 16).

173. **Staurastrum furcigerum** Bréb.

(Pl. CLVI, figs. 7, 8, 11.)

Staurastrum furcigerum Bréb. in Menegh. Synops. Desm. 1840, p. 226; Arch. in Pritch. Infus. 1861, p. 743, t. 3, f. 32, 33; Rabenh. Flor. Europ. Alg. 1868, p. 219; Arch. in Quart. Journ. Micr. Sci. 1871, p. 95; Nordst. Norges Desm. 1873, p. 36; Kirchn. Alg. Schles. 1878, p. 167; Wolle, Desm. U. S. 1884, p. 146, t. 48, f. 12, 13, t. 52, f. 23, 24; Cooke, Brit. Desm. 1887, p. 178, t. 62, f. 1; Hansg. Prodr. Alg. Böhm. 1888, p. 215; Nordst. Bornholm Desm. 1888, p. 207; De Toni, Syll. Alg. 1889, p. 1224; Heimerl, Desm. alp. 1891, p. 607; West, Alg. W. Ireland, 1892, p. 186; Alg. Engl. Lake Distr. 1892, p. 21; Roy & Biss. Scott. Desm. 1893, p. 20; West & G. S. West, Alg. S. England, 1897, p. 496; G. S. West, Variation Desm. 1899, p. 396; West & G. S. West, Alg. N. Ireland, 1902, p. 47;

G. S. West, Brit. Freshw. Alg. 1904, p. 172, f. 65 G; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 175; Kaiser, Alg. Traunstein u. Chiemgau, I, 1914, p. 152.
? *Xanthidium articulatum* Corda in Alm. de Carlsbad, 1840, p. 213, t. 5, f. 35.
Phycastrum furcigerum Kütz. Phyc. Germ. 1845, p. 138.
Didymocladon furcigerum Ralfs, Brit. Desm. 1848, p. 144, t. 33, f. 12; Delp. Spec. Desm. subalp. 1877, p. 174, t. 14, f. 24–27.
Asteroxanthium furcigerum Kütz. Spec. Alg. 1849. p. 183.
Phycastrum (Amblyactinium) furcigerum Näg. Gatt. einz. Alg. 1849, p. 125.
Didymidium (Staurastrum) furcigerum Reinsch, Alg. Frank. 1867, p. 170.

Cells large, slightly longer than broad, excluding the processes, deeply constricted, sinus acute, narrow at first, then opening more widely; semicells elliptical, dorsal and ventral margins almost equally convex, lateral angles produced into short stout processes, tipped with two or three sharp spines, apex of semicell with an upper series of processes, similar or perhaps slightly shorter than the lower series, and projecting vertically above them; processes with concentric series of denticulations. Vertical view triangular (or up to 9-radiate), lateral margins concave, angles somewhat inflated and then produced into short processes; apex with a similar short process in each angle. Semicells with a single chloroplast and a central pyrenoid.

Zygospore spherical, with numerous spines which are stouter at the base, and twice dichotomous at the apex.

Length, without processes, 35–48 μ; including processes, 50–70 μ; breadth, including processes, 45–68 μ; breadth of isthmus 13–18 μ; diam. zygosp., without appendages, 39 μ; with appendages, 74 μ.

ENGLAND. — Plankton of Crummock Water and Ennerdale Water, Cumberland! Westmoreland, and in the plankton of Brother's Water and Hawes Water! Lancashire! (*Ralfs*). W. and N. Yorks (zygospores from Pilmoor, N. Yorks)! Cheshire (*Ralfs*). Essex! Burnham Beeches, Bucks! Plankton of Bracebridge Pool, Sutton Park, Warwicks! Worcs! Berks (*Griffiths*). Surrey! Sussex (*Ralfs*). Hants! Dartmoor, Devon (*Harris*). Cornwall! (*Marquand*).

WALES.—Capel Curig, Carnarvon! (*Cooke & Wills*). Dolgelly, Merioneth (*Ralfs*). In the plankton!

Scotland.—General! zygospores from Dinnet, Aberdeen (*Roy & Biss.*). Orkneys! Not uncommon in the plankton of Loch Morar, Inverness, Loch Tay, Perth, and Lochs Fadaghoda and an Tomain, Lewis, Outer Hebrides!

Ireland.—Mayo! Galway, and in the plankton of Lough Corrib! Kerry! Plankton of Lough Neagh! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Servia. Italy. Norway. Sweden. Denmark. Bornholm. Finland. Poland. Faeroes. Iceland. Greenland. Siberia. Mongolia. United States and Alaska. Yukon. Nova Scotia. Patagonia.

St. furcigerum is a very common species often found in quantity in pools amongst *Myriophyllum*, *Sphagnum* or *Utricularia*. It is also a general constituent of the plankton of British lakes. The upper whorl of processes is liable to variation, and transitional forms between the type and forma *eustephana* are not infrequent (*vide infra*).

Forma **eustephana** (Ehr.) Nordst. (Pl. CLVII, fig. 1.)

Desmidium eustephanum Ehr. Micr. Leb. S. & N. Amer. 1843, p. 124, t. 4, f. 23.

Staurastrum eustephanum Ralfs, Brit. Desm. 1848, p. 215; Arch. in Pritch. Infus. 1861, p. 742, t. 2, f. 3; Rabenh. Flor. Europ. Alg. 1868, p. 220; Wolle, Desm. U. S. 1884, p. 147, t. 48, f. 9, 10; Cooke, Brit. Desm. 1887, p. 177, t. 62, f. 2; West, Desm. Massach. 1889, p. 6, t. 3, f. 18; De Toni, Syll. Alg. 1889, p. 1223, West, Alg. N. Wales, 1890, p. 19; Alg. W. Ireland, 1892, p. 185; Roy & Biss. Scott. Desm. 1893, p. 19; West & G. S. West, Alg. S. England, 1897, p. 496; Cushman in Bull. Torr. Bot. Club, 1905, p. 228, t. 8, f. 19.

Stephanoxanthium eustephanum Kütz. Spec. Alg. 1849, p. 184.

Staurastrum furcigerum forma *eustephana* Nordst. Bornholm Desm. 1888, p. 207; G. S. West, Variation Desm. 1899, p. 396.

This form only differs from typical *St. furcigerum* in that the upper whorl of processes is doubled, consisting of 6 instead of the usual whorl of 3 in the ordinary triradiate specimen. The lower processes are quite normal.

Length, without processes, 40 μ; including processes, 58 μ; breadth, including processes, 57 μ; breadth of isthmus 12 μ.

ENGLAND.—Bowness and Loughrigg, Westmoreland! New Forest, Hants! Dartmoor, Devon (*Harris*). In the plankton!

WALES.—Capel Curig and Llyn Ogwen, Carnarvonshire! In the plankton!

SCOTLAND.—Spital of Glen Shee, Perth!

IRELAND.—In lakes, Clifden to Roundstone, and Ballynahinch, Galway! Glen Caragh, Kerry!

Geogr. Distribution.—Germany. New Zealand. United States.

The lower whorl of processes in forma *eustephana* do not seem, at any rate in British specimens, to have so many or as acute denticulations as in the type form. Furthermore the margins of the upper whorl of processes seem to be practically smooth.

It has been pointed out by G. S. West ('Variation Desm.' 1899, p. 396) that this form was correctly placed by Nordstedt as a form of *St. furcigerum*, since specimens have been observed in which one semicell was typical, and the other of the form *eustephanum*. Further, the zygospore figured on Pl. CLVI, fig. 8 shows the conjugation of a typical specimen of *St. furcigerum* with one of forma *eustephana*. This is an additional proof that the two forms are really the same species. Cushman ('Bull. Torr. Bot. Club,' 1905, t. 8, f. 19) also figures the zygospore of forma *eustephana*. His specimen shows rather more complicated appendages than the example figured above.

Forma **armigera** (Bréb.) Nordst. (Pl. CLVI, fig. 10.)

Staurastrum armigerum Bréb. Liste Desm. 1856, p. 136, t. 1, f. 22; Roy & Biss. Scott. Desm. 1893, p. 17, t. 3, f. 12.

St. pseudofurcigerum Reinsch, Spec. Gen. Alg. 1867, p. 20, t. 4 C, f. 1; Alg. Frank. 1867, p. 169, t. 11, f. 2; Wills, Alg. N. Wales, 1881, t. 5, f. 10; Cooke, Brit. Desm. 1887, p. 147, t. 61, f. 4; Hansgirg, Prodr. Alg. Böhm. 1888, p. 215.

St. furcigerum forma *armigera* Nordst. Desm. Bornholm 1888, p. 207; West & G. S. West, Alga-fl. Yorks. 1902, p. 98; Further Contrib. Plankton Scott. Lochs, 1905, p. 487.

St. furcatum var. *armigerum* West, Alg. N. Wales, 1890, p. 16; Alg. Engl. Lake Distr. 1892, p. 19; Alg. W. Ireland, 1892, p. 174.

Cells in form similar to the type, but with the lower whorl of processes somewhat longer than usual, and with an apical whorl of 6 accessory processes (in the usual triradiate form). All the processes are consider-

ably longer than usual, and their margins are crenulate rather than denticulate.

Zygospore spherical with numerous spines, broad at the base, and tapering to a fine, slightly bifid apex (*Roy*).

Length, without processes, 45 μ ; including the processes, 80 μ ; breadth, without processes, about 35 μ ; including processes, 70 μ ; breadth of isthmus 15 μ.

ENGLAND.—Cumberland ! Lancashire ! N. Yorks (*W. B. Turn.*). Surrey ! Hants ! Devon ! (*Harris*).

WALES.—Dolbadarn Castle !, Llyn Padarn !, and Capel Curig ! (*Cooke & Wills*), Carnarvonshire.

SCOTLAND.—Inverness, Aberdeen, Kincardine, Forfar, Perth, Stirling and Arran ; zygospores from Heughhead, near Aboyne, Aberdeen (*Roy & Biss.*). Sutherland and in the plankton of Loch nan Cuinne ! Plankton of Loch Luichart, Ross !, Loch Shiel, Inverness !, and Loch Tay, Perth !

IRELAND.—Ballynahinch, Galway ! Lower lake of Killarney, Kerry ! Adrigole, Cork ! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Turkey. Norway. Sweden. Finland. Poland. India. Australia. New Zealand. United States.

Var. **reductum** W. & G. S. West. (Pl. CLVI, fig. 9.)

St. furcigerum var. *reductum* West & G. S. West, Compar. Study Irish Lakes, 1906, p. 104, t. 11, f. 12.

Processes very much shorter than in the type, upper processes extremely short ; vertical view triangular, sides nearly straight or very slightly convex.

Length 43 μ ; breadth, including processes, 54 μ ; breadth of isthmus 21 μ.

ENGLAND.—Dartmoor, Devon (*Harris*).

IRELAND.—Plankton of Lough Corrib, Galway !

This variety is distinguished chiefly by the great reduction of the superior processes. In one semicell they were observed to be suppressed entirely.

174. **Staurastrum Arctiscon** (Ehr.) Lund.

(Pl. CLVII, fig. 5.)

Xanthidium No 2 Bailey, Amer. Bac. 1841, p. 291, t. 1, f. 15.
Xanthidium Arctiscon Ehr. Micr. Leb. S. u. N. Amer. 1843, p. 138; Ralfs, Brit. Desm. 1848, p. 212; Rabenh. Flor. Europ. Alg. 1868, p. 224; Kirchn. Alg. Schles. 1878, p. 155.
Staurastrum Arctiscon Lund. Desm. Suec. 1871, p. 70, t. 4, f. 8; Wills in Midl. Nat. 1881, t. 4, f. 5; Wolle, Desm. U. S. 1884, p. 148, t. 47, f. 9, 10; Cooke, Brit. Desm. 1887, p. 179, t. 63, f. 1; De Toni, Syll. Alg. 1889, p. 1226; Roy & Biss. Scott. Desm. 1893, p. 17; West & G. S. West, Some N. Amer. Desm. 1896, p. 269; Alg. N. Ireland, 1902, p. 47; Scott. Freshw. Plankton, I, 1903, p. 551; Further Contrib. Plankton Scott. Lochs, 1905, p. 487; Comp. Study Plankt. Irish Lakes, 1906, p. 87; Cushman in Bull. Torr. Bot. Club, 1907, p. 615; West & G. S. West, Phytopl. Engl. Lake Distr. 1909, p. 289; Brit. Freshw. Phytoplankton, 1909, p. 174.
St. munitum Wood, Freshw. Alg. N. Amer. 1873, p. 154, t. 13, f. 13.

Cells large, about $1\frac{1}{2}$ times longer than broad, excluding the processes, constriction fairly deep; sinus nearly rectangular with subacute apex; semicells broadly elliptical or subspherical, provided with 2 whorls of processes; lower whorl consisting of 9 processes, nearly horizontal, 5 of which are visible in the front view; upper whorl of 6 processes, ascending obliquely; processes nearly as long as the body of the semicell is broad, tipped with 3 spines, and with 2–7 series of denticulations; body of cell smooth. Vertical view nearly circular, with a marginal series of 9 processes, and an apical series of 6 shorter processes. Chloroplast axile with a central pyrenoid, and a lobe stretching into the base of each process.

Zygospore unknown.

Length, without processes, 66–96 μ; with processes, 100–155 μ; breadth, without processes, 46–68 μ; with processes, 92–160 μ; breadth of isthmus 24–33 μ.

England.—Plankton of Crummock Water and Ennerdale Water, Cumberland! Plankton of Brother's Water, Grasmere and Easedale Tarn, Westmoreland!

Wales.—Capel Curig! (*Cooke & Wills*) and Llyn Ogwen!, Carnarvonshire. In the plankton.

Scotland.—Birsemore Loch and Dalbagie, Aberdeen; Tobermory in Mull, Argyle (*Roy & Biss.*). Plankton of

Lochs Shin, Ghriama and nan Cuinne, Sutherland!, Loch Shiel, Inverness!, Loch Tay, Perth! and Loch Doon, Ayr!; of Loch Fadaghoda, Lewis, Loch Laxadale, Harris, and Loch nan Eun, N. Uist, Outer Hebrides!

IRELAND.—Near Lough Magrath, Donegal! Ballynahinch and lakes east of Lough Bofin, Galway! Plankton of Galway and Kerry!

Geogr. Distribution.—Germany. Norway. Sweden. Finmark. Finland. United States. Alaska. Brazil (var.).

This beautiful species is only found in the western parts of the British Isles, and is most abundant in plankton. The length of the processes tends to vary somewhat, but their arrangement is constant.

175. **Staurastrum sexangulare** (Bulnh.) Lund.
(Pl. CLVII, figs. 2, 3.)

Didymocladon sexangulare Bulnh. in Hedwigia, 1861, p. 51, t. 9 A, f. 1.
Staurastrum sexangulare Lund. Desm. Suec. 1871, p. 71, t. 4, f. 9; Arch. in Grevillea, 1881, p. 30; Cooke, Brit. Desm. 1887, p. 178, t. 62, f. 3, t. 64, f. 4; De Toni, Syll. Alg. 1889, p. 1224; Borge, Bidr. Sibir. Chlor. 1891, p. 10; Roy & Biss. Scott. Desm. 1893, p. 25; Comère, Desm. de France, 1901, p. 159, t. 11, f. 6; West & G. S. West, Alg. Ceylon, 1902, p. 181; Scott. Freshw. Plankton, 1903, p. 550; British Freshw. Phytoplankton, 1909, p. 202.
St. furcato-stellatum Reinsch, Contrib. Alg. et Fung. 1875, p. 85, t. 16, f. 1.
Didymocladon Stella Mask. N. Zeal. Desm. 1881, p. 308, t. 11, f. 9.
Staurastrum Stella Mask. N. Zeal. Desm. Add. 1883, p. 254.

Cells of medium or large size, usually a little longer than broad, excluding the processes, deeply constricted, sinus acute, open; semicells elliptical or subfusiform, apex slightly convex, lower margin slightly ventricose, produced at the lateral angles, which are deeply cleft, to form an upper and a lower process; semicells with a corresponding upper and lower whorl of processes stretching horizontally across the semicell (about 4 or 5 pairs visible); processes of lower whorl nearly horizontal or very slightly converging, those of upper whorl diverging; processes tipped with 3 or 4 spines and with 2 or 3 series of denticulations. Vertical view usually 5–7- (4–8-) radiate; lateral margins deeply concave, with a pair of flattened granules just within; angles produced to form long tapering processes, with an upper

process arising from the base of each lower process; processes of upper and lower whorls rarely exactly superimposed, the upper whorl being twisted very slightly in one direction. Chloroplast axile with a pyrenoid in each angle and a pair of lobes stretching into the base of each process.

Zygospore unknown.

Length, without processes, 44–60 μ; with processes, 74–100 μ; breadth, without processes, about 43–54 μ; with processes, 84–120 μ; breadth of isthmus 13–22 μ.

England.—Plankton of Ennerdale Water, Cumberland!

Wales.—Capel Curig, Carnarvonshire! (*Cooke & Wills*). In the plankton!

Scotland.—Near Brin, Inverness (*Roy & Biss.*) Rhiconich and in the plankton of Lochs nan Cuinne and Shin, Sutherland! Plankton of Loch near Cearnabahl and Lochs an Sgath, an Tomain, Langabhat, Stranabhat and Fadaghoda, Lewis, Outer Hebrides!

Ireland.—Connemara, Galway (*Arch.*). Plankton of Galway and Kerry!

Geogr. Distribution.—France. Germany. Norway. Sweden. Finland. Siberia. Central China. Japan. India. Ceylon. Burma. Singapore. Java. Australia. New Zealand.

This species differs from *St. furcigerum* Bréb., which is the only other British species having a pair of vertically placed processes at each angle, in the different shape of its semicells, its more open sinus, and in the distinctly lateral insertion of all its considerably longer processes. It is not an uncommon species in the plankton of some lakes in the western parts of the British Isles, but is otherwise very rare.

Var. **supernumerarium** W. & G. S. West. (Pl. CLVII, fig. 4.)

St. sexangulare var. *supernumerarium* West & G. S. West, Scott. Freshw. Plankton, 1, 1903, p. 551, t. 18, f. 8.

This variety has an extra small process placed between each upper and lower process.

Length, without processes, 51 μ; including processes, 65 μ; breadth, without processes, about 42–46 μ; including processes, 84·5–90 μ; breadth of isthmus 12 μ.

SCOTLAND.—Plankton of Loch Shin, Sutherland!

SPECIES TO BE ENQUIRED INTO.

STAURASTRUM MESOLEIUM Arch. in 'Ann. Mag. Nat. Hist.' v. 13, ser. 5, no. 74, 1884, p. 145; Cooke, 'Brit. Desm.' 1887, p. 190; Roy & Biss. 'Scott. Desm.' 1893, p. 190. "About medium sized, triangular in end view, in front view the angles a little produced, slightly spinulose. Resembling *St. oligacanthum* of Nordstedt, but not of de Brébisson." Size?

Hab.—Ireland: Callery Bog, Connemara. Scotland: Scotston Moor.

STAURASTRUM REPANDUM (Perty) Rabenh. 'Flor. Eur. Alg.' 1868, p. 221; De Toni, 'Syll. Alg.' 1889, p. 1143. *Phycastrum (Pachyactinium) repandum* Perty, 'Kleinst. Lebensf.' 1852, p. 210, t. 16, f. 26. "In front view $\frac{1}{20}'''$ long, each semicell prolonged at the lateral angles into sharp points; dorsal margin sloping gently downwards; vertical view triangular, angles and sides almost equal, angles drawn out into sharp points. Breadth, including the acute points, $\frac{1}{22}'''$.

Hab.—Scotland: Glen Callator, Aberdeen (*Roy & Biss.*). Switzerland.

STAURASTRUM STRENSALLENSE Turn. 'Alg. E. India,' 1893, p. 113, t. 17, f. 1. Of medium size, almost as long as broad; semicells depressed ovate, dorsal margin gently convex, ventral margin rounded and inflated, angles rounded; cell-wall covered densely with spines, disposed in 9 or 10 transverse series, that part near the isthmus being, however, smooth; sinus acute, opening widely. In vertical view triangular, sides slightly concave, angles broadly rounded. Length 65 μ; breadth 63 μ; breadth of isthmus 21 μ; length of spines 3–6 μ.

Hab.—England: Strensall Common, Yorkshire.

STAURASTRUM TRACHYNOTUM West, 'Alg. W. Ireland,' 1892, p. 176. *S. saxonicum* Reinsch, 'Spec. Gen. Alg.' 1867, p. 127, t. 24 C, f. 1–4. Var. ANNULATUM West, 'Alg. W. Ireland,' 1892, p. 176, t. 24, f. 16. Cells slightly longer than broad, deeply

constricted, sinus almost rectangular; semicells subfusiform, margins of semicell and angles provided with simple or emarginate spines; with a circle of large granules round the base of the semicell.

Hab.—Ireland: Carrantuohill, Cork.

[*Both St. trachynotum West, and its var. annulatum are probably forms of St. aculeatum (Ehr.) Menegh.*]

Excluded Species.

Staurastrum osteonum West, 'Alg. N. Wales,' 1890, p. 293, t. 5, f. 7.

Genus 19. **COSMOCLADIUM** Bréb. 1856.

Bréb. Liste Desm. 1856, p. 133.
De Bary, Conj. 1858, p. 77.
Arch. in Pritch. Infus. 1861, p. 752.
Arch. in Quart. Journ. Micr. Sci. vol. 7, 1867, p. 299.
Rabenh. Flor. Europ. Alg. 1868, p. 53.
Kirchn. Alg. Schles. 1878, p. 105.
Cooke, Brit. Desm. 1887, p. 78.
De Toni, Syll. Alg. 1889, p. 804.
Wille, in Engler. Naturl. Pflanzenfam. 1890, p. 11.
Comère, Desm. de France, 1901, p. 180.
G. S. West, Brit. Freshw. Alg. 1904, p. 173.

Cells minute, constricted at the middle, usually compressed and symmetrical in 3 planes at right angles to each other; semicells subpyramidate, elliptic or subreniform, cell-wall smooth; chloroplasts axile, usually one in each semicell, with a central pyrenoid and 4 projecting lobes; rarely with a single chloroplast in each cell, the pyrenoid occupying a central position. Individual cells indistinguishable from small species of *Cosmarium*, united, however, to form colonies of greater or smaller size (but never macroscopic), by means of gelatinous threads, single or double, secreted through pores in the cell membrane in the vicinity of the sinus. Colonies branched in an irregular fashion, usually free floating but sometimes of tree-like habit and attached to other algæ.

Zygospores only known in one or two species, more or

less spherical or sometimes angular, with short stout spines or obtuse protuberances.

The genus *Cosmocladium* is closely related to *Cosmarium*, from which, undoubtedly, it was originally derived. Its chief distinction from that genus is that the cells are joined together by means of slender gelatinous stalks, which are attached in the vicinity of the sinus. In this way, more or less branched colonies of varying size and shape are formed. It has been shown by Dr. Lütkemüller that the connecting gelatinous threads are secreted by special groups of pores situated near the base of the semicell. There may be single strands, or sometimes a pair of parallel gelatinous filaments joins the cells, depending on the number of pore groups present. In *C. constrictum* each semicell possesses one series of pores at its base, and here a single strand connects the cells, but in *C. Saxonicum* there is a group of these special pores on each side of the isthmus in each semicell, and in consequence the connecting strands are paired. In some of the other species it is impossible to say definitely whether the connecting strands are single or double, since they have not been sufficiently investigated on this point, and because the strands are so delicate that it is not easy to decide the question. The entire colony is, in addition, sometimes immersed in a delicate mass of jelly.

The genus *Cosmocladium* was much confused in earlier times with the Protococcales genus *Dictyosphærium*. It is most readily distinguished from this genus, however, not only by its constricted cells, but also by the fact that the cells are placed at various points, not merely at the periphery of the colony.

There are 5 British species of the genus, all of which are very rare. They are very minute and inconspicuous, and are very easily overlooked.

1. **Cosmocladium constrictum** Arch.

(Pl. CLVIII, figs. 1–3.)

Dictyosphærium sp. Arch. in Quart. Journ. Micr. Sci. 1865, p. 127.
D. constrictum Arch. ibid. 1867, p. 299; ibid. 1872, p. 422.
Cosmocladium constrictum Arch. ibid. 1875, p. 415; Josh. in Journ. Bot. 1883, p. 292; Cooke, Brit. Desm. 1887, p. 79; De Toni, Syll. Alg. 1889, p. 805; Roy & Biss. Scott. Desm. 1893. p. 254, t. 2, f. 7; Lütkem. Zellmembr. Desm. 1902, p. 359, t. 18, f. 31–33; West & G. S. West, Alga-fl. Yorks. 1902, p. 95; G. S. West, Brit. Freshw. Alg. 1904, p. 173, f. 66 A.

Cells very small, rather more than $1\frac{1}{2}$ times longer

than broad, subcylindrical, constriction extremely slight, semicells subpyramidate, narrowing slightly towards the apex, with gently rounded outlines; end view circular. Chloroplast axile, only one in each cell, with a central pyrenoid (occasionally 2 are present), and 4 radiating parietal lobes. Cells united by means of gelatinous filaments to form branched colonies of an irregular shape: cells not only at the ends of the strands but arranged distantly at intervals along them.

Zygospore spherical, with many short, stout, acute spines.

Length of cell 16–20 μ; breadth = thickness = 10–12 μ; breadth of isthmus 8·5–9 μ; diam. zygosp., without spines, 17–20 μ; with spines, 30 μ.

ENGLAND.—Pilmoor, near Thirsk, N. Yorks! Plankton of Bracebridge Pool, Sutton Park, Warwickshire! Dartmoor, Devon (*Harris*).

SCOTLAND.—"Old Road" and Heughhead, near Aboyne, Aberdeen; Dalbrake in Strachan, Kincardine; Buchanty, Perth (*Roy & Biss.*).

IRELAND.—Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—Sweden. Finland. United States.

C. constrictum is an alga which is frequently overlooked because the cells are small and are distantly arranged, so that the colonies are not dense. It is usually found in bogs, and although not frequent, is one of the commonest species of the rare genus *Cosmocladium*. The specimens found in the plankton of Bracebridge Pool consisted almost entirely of isolated cells.

It has been shown by Dr. Lütkemüller that in the cells of this species there are two series of minute pores, arranged closely together on either side of the isthmus. They are only present on one side of the cell—that side which is directed towards the centre of the colony, and extend about ⅔rds of the distance across the face of the cell when examined in front view. They are only rendered visible by special staining methods. These pores give rise to the gelatinous strands, which, extending from the isthmus of one cell to the next, unite the cells together.

2. **Cosmocladium perissum** Roy and Biss.

(Pl. CLVIII, figs. 4–7.)

Cosmocladium perissum Roy & Biss. Scott. Desm. 1893, p. 62, t. 2, f. 14; G. S. West, Brit. Freshw. Alg. 1904, p. 173, f. 66 C.

Cells minute, flattened, nearly as broad as long, constriction fairly deep and somewhat obtuse, opening widely; apex slightly concave, sides broadly rounded; cell-wall very pellucid and sometimes brownish in colour; end view elliptical; cells forming free colonies.

Zygospore large in proportion to the size of the cells, extremely irregular in shape, with several irregular and blunt spiny protuberances, reddish brown in colour.

Length 12–13 μ; breadth 10–12 μ; thickness 6 μ; diam. zygospore 15–20 μ (–27 μ; *West*).

SCOTLAND.—Aboyne, Aberdeen; Cammie in Strachan, Kincardine (*Roy & Biss.*). Clova Mts., Forfar!

This species never forms very large colonies, and more than 4 cells are scarcely ever found together. The cells occur in a simple row, loosely joined by very delicate gelatinous threads. The semicells have only two jelly-secreting pores each, one on either side of the isthmus, whereas both *Cosmocladium constrictum* and *C. Saxonicum* have quite a well-developed series of pores. This very slight development of secreting pores is responsible for the extreme delicacy of the connecting strands, and the small size of the colonies in *C. perissum* as compared with the two above-mentioned species.

3. **Cosmocladium pulchellum** Bréb.

(Pl. CLVIII, figs. 11, 12.)

Cosmocladium pulchellum Bréb. Liste Desm. 1856, p. 133, t. 1, f. 20; De Bary, Conj. 1858, p. 77; Ueber Cosmocladium, 1865, p. 329; Rabenh. Flor. Europ. Alg. 1868, p. 54; Kirchn. Alg. Schles. 1878, p. 105; De Toni, Syll. Alg. 1889, p. 804; Roy & Biss. Scott. Desm. 1893, p. 62; Comère, Desm. de France, 1901, p. 180, t. 15, f. 15; G. S. West, Brit. Freshw. Alg. 1904, p. 173, f. 66 B.

Cells small, somewhat longer than broad, deeply constricted, sinus narrow but opening more widely; semicells elliptical or subreniform; vertical view ellip-

tical. Chloroplasts axile, with a pyrenoid in the centre of each semicell. Cells united into colonies by means of gelatinous threads, sometimes with a tree-like habit and attached to other larger filamentous algæ (according to de Brébisson).

Zygospore unknown.

Length of cells 12–24 μ; breadth 11–16 μ; thickness 6–7 μ; breadth of isthmus 4–4·5 μ.

SCOTLAND.—Aboyne, Aberdeen; Bogandreep in Glen Dye, Kincardine; Clova Tableland, Forfar (*Roy & Biss.*). Rhiconich, Sutherland! Near Tarbert, Harris, Outer Hebrides!

Geogr. Distribution.—France. Germany. United States.

4. **Cosmocladium pusillum** Hilse.

(Pl. CLVIII, figs. 8–10.)

Cosmocladium pusillum Hilse in Bericht. d. Schles. Ges. 1865, p. 117; in Rabenh. Alg. Eur. 1867, no. 1963; Rabenh. Flor. Europ. Alg. 1868, p. 54; Kirchn. Alg. Schles. 1878, p. 105; De Toni, Syll. Alg. 1889, p. 805.
Cosmocladium subramosum Schmidle, Chlorophy.-fl. Torfstiche Virnheim, 1894. p. 49, t. 7, f. 8; West & G. S. West, Alg. N. Ireland, 1902, p. 42, t. 2, f. 13, 14.

Cells small, up to 1½ times longer than broad, deeply constricted, sinus linear for most of its length, then opening more widely; semicells oblong-elliptic, apex somewhat flattened, sides broadly rounded; in end-view elliptical; chloroplasts axile, with a pyrenoid in the centre of each semicell. Colonies usually small, rarely consisting of more than 8 cells, only very slightly or not at all branched, free-floating: cells mostly with their broad surface perpendicular to the direction of the connecting gelatinous threads; colonies sometimes enveloped in a very thin, scarcely-visible mucus.

Zygospore unknown.

Length of cell 11–12 μ; breadth 11–12 μ; thickness 5–6 μ; breadth of isthmus 2–3 μ.

IRELAND.—Lough Anna, Donegal! Rare in the plankton of Galway.

Geogr. Distribution.—Germany. Finland.

C. pusillum Hilse is one of the smallest species of the genus, and is very rare. It is uncertain whether the delicate connecting strands between the cells are single or double. *C. pusillum* is distinguished from *C. perissum* and *C. pulchellum* by the special characters of its colonies, and by its cells equal in length to their breadth, with oblong semicells and deep, linear sinus.

That *C. subramosum* Schmidle is synonymous with *C. pusillum* Hilse was pointed out by Dr. Lütkemüller in a letter to the late Professor G. S. West in 1912. Dr. Lütkemüller had carefully examined the original specimens of Hilse in Rabenhorst's 'Alg. Exs.' no. 1963, and compared them with preserved material of *C. subramosum* identified by Schmidle. He came to the conclusion that the two were identical both in the form of their cells and the character of the colonies.

5. **Cosmocladium Saxonicum** De Bary.

(Pl. CLVIII, figs. 13–16.)

Cosmocladium Saxonicum De Bary, *Cosmocladium*, 1865, pp. 321–9, t. 4, f. 1–3; Arch. in Quart. Journ. Micr. Sci. vol. 7, 1867, p. 298; Rabenh. Flor. Eur. Alg. 1868, p. 54; Arch. in Quart. Journ. Micr. Sci. 1874, p. 212; Cooke, Brit. Desm. 1887, p. 78, t. 35, f. 16; De Toni, Syll. Alg. 1889, p. 804; Roy & Biss. Scott. Desm. 1893, p. 63; ? West & G. S. West, Alg. S. England, 1897, p. 492: Schröder, *Cosm. Saxonicum*, 1900, p. 15. t. 1; Lütkem. Zellm. Desm. 1902, p. 359, t. 18, f. 34–36; West & G. S. West, Notes Alg. III. 1903, p. 10; Comp. Study Plankt. Irish Lakes, 1906, p. 102; Kofoid. Plankt. Ill. River, 1908, p. 61; West & G. S. West, Brit. Freshw. Phytoplankton, 1909, p. 168.

Cells larger than in any other British species of the genus, about $1\frac{1}{2}$ times longer than broad, deeply constricted, sinus acute angled, opening widely; semicells subelliptic-reniform, dorsal margin much more convex than the ventral; in vertical view elliptic; chloroplasts axile, with one pyrenoid in each semicell, and 4 lobes projecting from the central mass towards the cell-wall. Cells united by 2 parallel gelatinous filaments into colonies of varying size, consisting only of 2 or 3 cells, or up to 90 in a single colony; colonies free-floating, and sometimes immersed in a delicate jelly; cells usually parallel to each other, and with their broad faces perpendicular to the direction of the strings, so that normally their side view is presented to the observer.

Zygospore recorded by Grönblad ('Desm. Keuru,' 1920, p. 82), but without description or figure.

Length 22–27 μ; breadth 18–20 μ; thickness 12–15 μ; breadth of isthmus 3·5–7 μ.

ENGLAND.—? Thursley Common, Surrey (identified with doubt)!

WALES.—Capel Curig! and pool near Llyn Elsie, Bettws-y-coed (*Arch.*), Carnarvonshire! In the plankton!

SCOTLAND.—Dalbrake and Heughhead in Strachan, Kincardine (*Roy & Biss.*). Near Tarbert, Harris, Outer Hebrides!

IRELAND.—Dublin; Carrick Mts., Wicklow; Callery Bog (*Arch.*). In the plankton!

Geogr. Distribution.—Germany. Austria. Norway. Finland. United States.

Both Schröder and Lütkemüller have carefully investigated this species, and found that each cell possesses 4 special groups of pores near the isthmus which are responsible for the secretion of the gelatinous connecting threads (*cf.* Pl. CLVIII, fig. 16). These pores are seen in the basal view of the semicell lying at opposite poles of the aperture which represents the isthmus. The connecting threads appear early during cell division and are seen as delicate strands stretching between the older semicells, becoming longer and stronger as the cells reach maturity. They very often show somewhat fusiform thickenings between each pair of cells, the significance of which is not properly understood.

Genus 20. **OOCARDIUM** Näg. 1849.

Näg. Gatt. einz. Alg. 1849, p. 74.
Kütz. Spec. Alg. 1849, p. 196.
Kütz. Tab. Phyc. II, 1850, t. 83, f. 5.
Rabenh. Flor. Eur. Alg. 1868, pp. 13, 53.
De Toni, Syll. Alg. 1889, p. 658.
Senn in Botan. Zeitung, 1899, p. 81.
G. S. West, Brit. Freshw. Alg. 1904, p. 174.

Cells essentially of the *Cosmarium* type, small, depressed, considerably broader than long, very slightly constricted, unequally flattened on the two sides, so that the cells are only symmetrical in 2 planes at right angles instead of 3, as is general in *Cosmarium* and the

allied genera; cell-wall smooth; chloroplasts axile with a central pyrenoid in each semicell; cells embedded in the ultimate ends of a radiating and branched system of gelatinous strands, the latter being encrusted with lime, aggregated in colonies 1–2 mm. in diameter.

Zygospore angular, with several mamillate projections.

This genus is closely related to *Cosmarium* and *Cosmocladium*. From the latter genus it is distinguished primarily by the fact that its cells are produced only at the periphery of the gelatinous and usually lime-encrusted macroscopic colony. The more asymmetrical form of the cells in *Oocardium* is of no great importance, since it has been shown by Senn that this is an effect of the deposition of lime, and that if cultures are kept in lime-free water, so that lime cannot be deposited, and the colonies simply remain gelatinous, the cells become more symmetrical.

The genus has been alternately placed in the Palmellaceæ (Protococcales) or the Desmidiaceæ by various authors since it was described by Nägeli. There is no doubt, however, as to its real affinities. The structure of its cell-wall and the nature of its cell-division are sufficient to prove that it is a true Desmid. The final proof of its systematic position has recently been brought forward by the present writer, who was fortunate enough to find the zygospores in some collections of algæ from India. There is only one known species of the genus.

1. **Oocardium stratum** Näg.

(Pl. CLIX, figs. 1–8; Pl. CLXVII, figs. 1–4.)

Oocardium stratum Näg. Gatt. einz. Alg. 1849, p. 75, t. 3 A; Kütz. Spec. Alg. 1849, p. 196; Tab. Phycolog. 1850, v. 2, t. 83, f. 5; Rabenh. Flor. Eur. Alg. 1868, p. 53; De Toni, Syll. Alg. 1889, p. 658; Senn, Colonie-bildende Alg. 1899, p. 81; *Oocardium stratum*, etc. 1899, p. 221; W. & G. S. West, Alga-fl. Yorks. 1902, p. 130; Lütkem. Zellmem. Desm. 1902, p. 360, t. 18, f. 37, 38, t. 19, f. 4–6; G. S. West, Brit. Freshw. Alg. 1904, p. 174, f. 66, D–F; Virieux, Alg. et Peridin. 1913, p. 4.

Colonies small, 1–2 mm. in diameter, hemispherical or longer column-like structures, gregarious, bright green. Cells small, about $1\frac{1}{3}$ times broader than long in the front view (*i. e.* that in which the largest face is visible and the constriction horizontal), depressed, very

slightly constricted, unequally depressed on the two sides so that the cell is longer on the one side than the other; lateral view oblong-elliptic, slightly longer than broad, with the faintest indication of a constriction; vertical view oblong-elliptic, ratio of axes 1 : $1\frac{1}{2}$. Chloroplasts axile, one in each semicell, concentrated in the front view towards the broader side of the cell, with a central pyrenoid in each chloroplast. Cells embedded in the ultimate ends of branched gelatinous strings, each strand of which is surrounded by a hollow cylinder of lime, from the apex of which the cell just protrudes; cell inserted in the tube so that the broader end of the cell, containing the greater part of the chloroplast, is directed towards the periphery, and the narrow end within the tube, with the constriction in a vertical direction.

Zygospores rectangular or polyhedral, with several large mamillate projections; membrane smooth.

Length 13–20 μ; breadth, 18–24 μ; thickness 17 μ; diam. zygosp. (of var. *minor* with cells 7–8 μ long, 12–14 μ wide) 15–20 μ.

England.—Gordale and Austwick, W. Yorks!

Ireland.—Leinster Province (*Adams*).

Geogr. Distribution.—France. Germany. Austria. India (form).

This remarkable Desmid is very rare and only occurs in streams in limestone districts, usually in waterfalls or in swiftly flowing water, where it forms a calcareous deposit on rocks, stones or even twigs.

Its preference for situations in which an abundance of lime is available is rather peculiar, since the majority of Desmids strictly avoid such localities.

The gelatinous threads, containing at their extremity the algal cells, become enclosed in cylinders of lime by the metabolic activities of the living cell, whereby carbon dioxide is withdrawn by the algæ for the purpose of photosynthesis from the water in which much calcium carbonate is also dissolved. As a result of the removal of this carbon dioxide, the calcium carbonate is no longer as soluble as before, and consequently comes out of solution and is deposited round the algal cells. In order that it shall not thus be completely encased in lime, the

cell begins actively to secrete mucilage through the special pore organs of its cell-wall, by which means the thin layer of lime is ruptured, and the cell is lifted bodily in the mucilage out of the stony mass. In this way the tiny cylinders of lime are continually increasing in length, and the cells, by secreting mucilage, are raised higher and higher at the same time.

Cell-division proceeds as in ordinary Desmids, and the two daughter-cells secrete, when fully developed, their own gelatinous stalks, which in time become encrusted with lime. Thus as the cells increase in number the lime cylinders also increase in number, so that there is always a single cell at the top of one lime tube. A layer of lime as much as ·5 cm. thick may be deposited in a single year.

Genus 21. **SPHÆROZOSMA** Corda, 1835.

Corda in Alm. de Carlsbad, 1835, p. 207; ibid. 1840, p. 205.
Ralfs in Ann. Mag. Nat. Hist. 1845, vol. 16, p. 13.
Hass. Brit. Freshw. Alg. 1845, p. 348.
Ralfs, Brit. Desm. 1848, p. 65.
De Bary, Conj. 1858, p. 76.
Arch. in Pritch. Inf. 1861, p. 723.
De Not. Desm. Ital. 1867, p. 20.
Rabenh. Flor. Europ. Alg. p. 148.
Delp. Spec. Desm. subalp. 1873, p. 77.
Wood, Freshw. Alg. N. Amer. 1873, p. 123.
Kirchn. Alg. Schles. 1878, p. 133.
Gay, Monogr. loc. Conj. 1884, p. 42 (in part).
Wolle, Desm. U. S. 1884, p. 28.
Cooke, Brit. Desm. 1887, p. 3.
De Toni, Syll. Alg. 1889, p. 788 (in part).
Wille in Engler, Nat. Pflanzenfam. 1890, p. 14.
Turn. Alg. E. India, 1893, p. 140 (in part).
Comère, Desm. de France, 1901, p. 198.
G. S. West, Brit. Freshw. Alg. 1904, p. 174.

Cells usually very small, flattened and deeply constricted; sinus open or narrow and linear; semicells elliptical, oblong or subrectangular, cells united to form long filaments by means of special apical appendages, often twisted and enveloped in a mucous investment; apex of each semicell provided with one or two pairs of small rounded tubercles or short capitate processes, which are closely applied to the corresponding processes of the next cell. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore globose, rectangular or oblong, smooth, or furnished with simple spines.

Sphærozosma is distinguished from all other colonial Desmids by its short apical processes. The only other genus in which similar processes occur is *Onychonema*, but here they are very much longer, so long as to overlap the cells in a very characteristic fashion.

Dr. Lütkemüller in 'Zellmem. Desm.' 1902, p. 367, has expressed the opinion that the short apical processes are not in themselves the effective means by which the cells of the filaments are united. He found that the real connecting link is a thin gelatinous cushion stretching between adjacent cells, in which the processes of both are embedded. He further suggested that possibly the real function of the apical processes is to counteract to some extent the tendency of the filament to twist, a tendency which, if allowed to become too strong, would eventually lead to the breaking up of the filament.

The processes are sometimes very delicate, and only seen with difficulty. They are usually observed most readily on the free ends of the filament, or on isolated cells.

There are 5 British species of the genus, none of which is abundant.

1. **Sphærozosma Aubertianum** West.

(Pl. CLIX, fig. 13.)

Sphærozosma Aubertianum West, Freshw. Alg. Maine, 1889, p. 206, t. 291, f. 17; Alg. W. Ireland, 1892, p. 115, t. 19, f. 1; West & G. S. West, Some N. Amer. Desm. 1896, p. 230, t 12.

Cells small, about as long as broad, or a little broader, deeply constricted, sinus acute, almost linear at first, then opening more widely; semicells narrowly elliptic or almost elliptic-oblong, sides and apex gently rounded, lateral margins with two distant minute granules, arranged vertically; semicells in side view subspherical, with the connecting processes on each side of the apex; vertical view oblong-elliptic.

Zygospore globose or subglobose, with many long, curved, and sharp spines, broad and hollow at the base. Length of spines variable.

Length of cells 16·5–19 μ ; breadth 18–23 μ ; breadth of isthmus 5–8 μ ; diam. zygosp. without spines 19–24 μ ; including spines, 37·5–42 μ.

England.—Plankton of Ennerdale Water, Cumberland !

Wales.—Capel Curig, Carnarvonshire !

Ireland.—Common in the plankton of Lough Accorymore, Achill Isle, Mayo ! Derryclare Lough, Galway !

Geogr. Distribution.—Finland. Australia. United States.

Var. **Archeri** (Gutw.) W. & G. S. West. (Pl. CLIX, figs. 14–17.)

Sphærozosma vertebratum Arch. in Q. J. M. S. 1865, v. 5, p. 170 ; ibid. 1866, v. 6, p. 274.
Sph. vertebratum forma Nordst. in Wittr. et Nordst. Alg. exs. no. 967, fasc. 21, p. 34, 1889.
Sph. Archeri Gutw. Flor. Glon. Okolic Llowa, 1891, p. 29, t. I, f. 4 ; Roy & Biss. Scott. Desm. 1893, p. 10 ; Gutw. Flor. Glonów Okolic Tarnapola, 1894, p. 77.
? *Sph. filiformis* Turn. Alg. E. India, 1893, p. 142, t. 17, f. 20.
Sph. Aubertianum var. *Archeri* West & G. S. West, Some N. Amer. Desm. 1896, p. 230 ; Furth. Contrib. Plankton Scott. Lochs, 1905, p. 505, t. 6, f. 7.

Differs from the type only in the fact that each semicell is provided with two horizontal series of granules.

Zygospore exactly similar to that of the type.

Length 12–17 μ ; breadth 19–27·5 μ ; thickness about 11·5 μ ; breadth of isthmus 5·5–7 μ ; diam. zygosp., without spines, 19 μ ; length of spines up to 17 μ.

England.—Plankton of the English Lake District !

Wales.—In the plankton !

Scotland.—Near Alford and Braemar, Aberdeen (*Roy & Biss.*). Plankton of Lochs Shiel and Bairness, Inverness !, and of Loch Fadaghoda, Lewis, Outer Hebrides !

Geogr. Distribution. — Sweden. Poland. India. Australia.

Transitional forms between *Sph. Aubertianum* and its var. *Archeri* are not at all uncommon, the two rows of granules being very often incomplete. The variety is frequent in plankton.

Lütkemüller (' Desm. Böhm.' 1910) expresses the opinion that

true warts do not occur in this species any more than in *Sph. vertebratum* Ralfs, but that it is the hardened ends of gelatinous strands exuding from 2 horizontal rows of pores which are often visible even in the unstained cells. This is a good suggestion, since the so-called granules are very delicate and often difficult to see. From these considerations it would seem that *Sph. Aubertianum* and its var. *Archeri* are quite possibly synonymous.

2. **Sphærozosma vertebratum** (Bréb.) Ralfs.

(Pl. CLIX, figs. 9, 10.)

Desmidium vertebratum Bréb. Alg. Falaise, 1835, p. 269, t. 2.
Isthmia vertebrata Menegh. Synops. Desm. 1840, p. 205.
Desmidium compressum Ralfs in Ann. Mag. Nat. Hist. vol. 9, 1842, p. 253.
Isthmosira vertebrata Kütz. Phyc. Germ. 1845, p. 141; Spec. Alg. 1849, p. 188.
Sphærozosma unidentata Ralfs in Ann. Mag. Nat. Hist. vol. 16, 1846, p. 14.
Sph. vertebratum Ralfs, Brit. Desm. 1848, p. 65, t. 6, f. 1, t. 32, f. 2; De Bary, Conj. 1858, p. 45, t. 4, f. 32–34; Arch. in Pritch. Inf. 1861, p. 724, t. 1, f. 15–17; Rabenh. Krypt.-fl. Sachs. 1863, p. 178; Jacobs. Desm. Danem. 1875, p. 211; Kirchn. Alg. Schles. 1878, p. 133; Wolle, Desm. U. S. 1884, p. 30, t. 4, f. 13; Cooke, Brit. Desm. 1887, p. 3, t. 2, f. 1; Hansg. Prodr. Alg. Böhm. 1888, p. 170; De Toni, Syll. Alg. 1889, p. 789; West, Alg. Engl. Lake Distr. 1892, p. 6; Roy & Biss. Scott. Desm. 1893, p. 10; Comère, Desm. de France, 1901, p. 199, t. 16, f. 12; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Lütkem. Zellmem. Desm. 1902, pp. 354, 366, t. 19, f. 8; G. S. West, Brit. Freshw. Alg. 1904, p. 175, f. 67 C.

Cells small, about as long as broad, or sometimes a little broader, constriction fairly deep, sinus narrow, linear, obtuse at the apex; semicells nearly oblong or subreniform, slightly narrower at the apex; lower margin nearly straight, upper angles very rounded, apex flattened; lateral view of cell oblong, slightly constricted in the middle, semicells short and oval; apical processes median; cell-wall smooth. Chloroplasts axile, with a central pyrenoid in each semicell.

Zygospore smooth and spherical (*Ralfs*).

Length 19 μ; breadth 21–24 μ; thickness 12 μ; breadth of isthmus 9–10 μ; diam. zygospore 21 μ.

England. — Bassenthwaite Water, Cumberland! Westmoreland! (*Ralfs*). Rawcliffe Common and Ingleborough, W. Yorks! Strensall Common (*W. B. Turner*) and Pilmoor, N. Yorks! Riccall Common, E. Yorks!

Mitcham Common, Surrey! Sussex and Kent (*Ralfs*). Dartmoor, Devon (*Harris*). Cornwall! (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*) and Glyder Fawr (*Roy*), Carnarvonshire. Dolgelly, Merioneth (*Ralfs*). In the plankton!

SCOTLAND.—Aberdeen, Kincardine, Forfar, Perth (*Roy & Biss.*). Shetlands! Not uncommon in the plankton! Plankton of Loch Gorma, Inverness; and of Loch Diracleet, Harris, Outer Hebrides!

IRELAND.—In the plankton, Mayo! Derryclare Lough, Ballynahinch, and in the plankton, Galway! Lough Guitane and in the plankton, Kerry!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Galicia in Austria. Hungary. Italy. Turkey. Norway. Sweden. Denmark. Bornholm. Finland. N. and S. Russia. Faeroes. India. United States. Patagonia.

Forma **minor** West. (Pl. CLIX, fig. 12.)

Sph. vertebratum f. *minor* West, Add. Alg. W. Yorks. II, 1891, p. 244; Alg. Engl. Lake Distr. 1892, p. 6, t. 9, f. 3.

Differs from the type in its smaller size, its relatively broader isthmus, and somewhat more depressed cells.

Length 8–10 μ; breadth 12–14 μ; breadth of isthmus 7·5–8 μ.

ENGLAND.—Harrop Tarn, Cumberland! Brother's Water, Rydal Fell, and Stickle Tarn, Westmoreland! Malham Tarn, W. Yorks!

Var. **punctulatum** W. & G. S. West. (Pl. CLX, fig. 12.)

Sph. punctulatum West, Alg. Maine, 1891, p. 1, t. 315, f. 1, 2.
Sph. vertebratum var. *punctulatum* West & G. S. West, Freshw. Alg. Orkneys & Shetlands, 1905, p. 28; Phytoplankton Engl. Lake Distr. 1909, p. 290.

Cells more angular than in the type, and distinctly punctate.

Length 14–16 μ; breadth 17·5–20 μ; thickness 10 μ; breadth of isthmus 8–9·5 μ.

England.—Plankton of Ennerdale Water, Cumberland !, and of Brother's Water, Westmoreland !
Scotland.—Near Scalloway, Shetlands !

The differences between this variety and *Sph. Aubertianum* var. *Archeri* are often very slight, so that it is difficult to distinguish between them. The latter Desmid seems, however, to be relatively longer, whilst the punctulations in *Sph. vertebratum* var. *punctulatum* are more evenly distributed.

Var. **latius** W. & G. S. West. (Pl. CLIX, fig. 11.)

Sph. vertebratum var. *latius* West & G. S. West, Alg. S. Engl. 1897, p. 497, t. 6, f. 7.

Cells much wider than in the type, up to $1\frac{2}{3}$ times broader than long; sinus narrower and deeper; apex of semicell more convex.

Length 15–16 μ; breadth 25–27 μ; breadth of isthmus 5·5–7·5 μ.

England.—Esher West End Common, Surrey !

3. Sphærozosma excavatum Ralfs.
(Pl. CLX, figs. 1–3.)

Sphærozosma excavatum Ralfs in Ann. Mag. Nat. Hist. vol. 16, 1845, p. 15, t. 3, f. 8; Brit. Desm. 1848, p. 67, t. 6, f. 2; De Bary, Conj. 1858, p. 45; Arch. in Pritch. Inf. 1861, p. 724; Rabenh. Krypt.-fl. Sachs. 1863, p. 178; Reinsch, Alg. Frank. 1867, p. 199; De Not. Desm. Ital. 1867, p. 29, t. 1, f. 5; Rabenh. Flor. Europ. Alg. 1868, p. 149; Nordst. Desm. Brasil, 1869, p. 205; Jacobs. Desm. Danem. 1875, p. 211; Kirchn. Alg. Schles. 1878, p. 133; Wolle, Desm. U. S. 1884, p. 29, t. 4, f. 8–12; Cooke, Brit. Desm. 1887, p. 4, t. 2, f. 2; Hansg. Prodr. Alg. Böhm. 1888, p. 170; De Toni, Syll. Alg. 1889, p. 790; West, Alg. N. Wales, 1890, p. 6; Alg. Engl. Lake Distr. 1892, p. 6; Alg. W. Ireland, 1892, p. 115; Gutwin. Flor. Glonów Galic. 1892, p. 15; Roy & Biss. Scott. Desm. 1893, p. 10; West & G. S. West, Some N. Amer. Desm. 1896, p. 231, t. 12, f. 9; Comère, Desm. de France, 1901, p. 198, t. 16, f. 14; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. N. Ireland, 1902, p. 59; G. S. West, Brit. Freshw. Alg. 1904, p. 175, f. 67, D–F; West & G. S. West, Freshw. Alg. Orkneys & Shetlands, 1905, p. 28; Cushman in Rhodora, 1905, p. 264; in Bull. Torr. Bot. Club, 1905, p. 552; ibid. 1907, p. 615.
Isthmosira excavata Kütz. Spec. Alg. 1849, p. 189.

Cells very small, usually only slightly longer than broad, but sometimes as much as twice as long as broad, constriction moderately deep, sinus widely excavated,

obtuse; semicells broadly oval, isthmus slightly elongated; lateral view of cell oblong-elliptic, sides slightly concave; vertical view oblong with rounded ends and 4 minute attaching processes on the long margins. Cell-wall usually smooth, sometimes with horizontal rows of minute granules. Chloroplasts axile, one in each semicell with a central pyrenoid.

Zygospore rather large in proportion to the size of the cells, oval or spherical, wall quite smooth. Ralfs ('Brit. Desm.' 1848) records the occurrence of lateral conjugation in this species.

Length 7·5–12 μ; breadth 7–14 μ; breadth of isthmus 3·5–6·5 μ; thickness 5–7 μ; length of zygospore 10·2–16 μ; breadth 9–11 μ.

ENGLAND. — Cumberland! Westmoreland! (*Ralfs*). Lancashire (*Ralfs*). W., N., and E. Yorks! Leicester (*Roy*). Burnham Beeches, Bucks! Warwicks (*Wills*). Gloucester (*Ralfs*). Surrey; zygospores from Puttenham and Thursley Commons! Sussex; Kent (*Ralfs*). Hants! (*Roy*); zygospores from New Forest! Devon! (*Harris*). Cornwall! (*Ralfs*).

WALES.—Snowdon!, Llyn Padarn!, Llyn Idwal!, Capel Curig! (*Cooke & Wills*) and Glyder Fach (at 2200 feet)!, Carnarvonshire. Radnor!

SCOTLAND.—General and frequently conjugated! (*Roy & Biss.*). Shetlands!

IRELAND.—General! Wicklow! Plankton of Galway!

Geogr. Distribution.—France. Germany. Switzerland. Galicia in Austria. Hungary. Servia. Italy. Portugal. Norway. Sweden. Denmark. Finland. S. Russia. Nova Zembla. Spitzbergen. Greenland. India. Australia. Abyssinia. Central Africa. United States. N.W. Canada. Brazil.

Var. **subquadratum** *var. nov.* (Pl. CLX, figs. 4, 5.)

Sph. excavatum var. *subquadratum* West & G. S. West in manuscript.

Cells relatively broader than in the type, deeply constricted, sinus narrow and obtuse at its apex; semicells

oblong, upper angles more broadly rounded than the lower ones; vertical view narrowly elliptic.

Length 7·8–8·8 μ; breadth 9–10 μ; breadth of isthmus 2·5–3 μ; thickness 3·7 μ.

ENGLAND.—Stickle Tarn and Brother's Water, Westmoreland!

This tiny variety has a very different appearance from the typical form, and bears a strong resemblance to *Sph. vertebratum* Ralfs forma *minor* West, from which it differs in its extremely deep constriction.

4. **Sphærozosma granulatum** Roy & Biss.

(Pl. CLX, figs. 6, 7.)

Sphærozosma excavatum forma *Javanica* Nordst. Alg. et Char. I, 1880, p. 3.
? *Sph. spinulosum* Delp. in Wolle, Desm. U. S. 1884, p. 31, t. 4, f. 14.
Sph. granulatum Roy & Biss. Jap. Desm. 1886, p. 242, f. 17; Nordst. Freshw. Alg. N. Zeal. 1888, p. 28; De Toni, Syll. Alg. 1889, p. 791; Roy, Freshw. Alg. Enbridge Lake and Vicin. 1890, p. 335; Anderss. Sverig. Chlorophy. 1890, p. 9; West, Alg. Maine, 1891, p. 353; Alg. Engl. Lake Distr. 1892, p. 6; Alg. W. Ireland, 1892, p. 115; Lütkem. Desm. Attersees, 1893, p. 539; Roy & Biss. Scott. Desm. 1893, p. 10; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. N. Ireland, 1902, p. 59; Alg. Ceylon, 1902, p. 193; Alg. Orkneys & Shetlands, 1905, p. 28.

Cells small, about as long as broad, constriction deep and open; semicells elliptical, lateral margins rounded, apex straight; apical processes widely separated; semicells with a group of minute granules at each lateral margin, about 3 of which are visible; semicells from the side rounded, with about 6 small granules surrounding a central one. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore cubical, smooth, with one or two short, stout, and blunt spines on each angle (*Roy*).

Length 8–9 μ; breadth 8–10 μ; breadth of isthmus 4–5 μ; length and breadth of zygosp. 14·5 μ; length of spines 3·5 μ.

ENGLAND.—Wastdale, and in the plankton of Ennerdale Water, Cumberland! Bowness, and in the plankton of Hawes Water and Codale and Easedale Tarns, Westmoreland! Hampsfell, Lancashire! Pilmoor, N. Yorks!

Riccall Common, E. Yorks! Epping Forest, Essex! Warwicks! Worcs! Near Chapel Wood, and Puttenham Common, Surrey! Enbridge Lake, Hants., with zygospores (*Roy*).

WALES.—Llyn Idwal, Llyn Ogwen, Llyn Geirionedd, and Llyn Bodgynwydd, Carnarvonshire!

SCOTLAND. — Sutherland!, Inverness!, Aberdeen, Kincardine, Forfar, Perth! and Argyle (*Roy & Biss.*). Not uncommon in the plankton! Frequent in Lewis, Outer Hebrides! Shetlands and also in the plankton!

IRELAND. — Donegal! Mayo! Galway! Kerry! Armagh!

Geogr. Distribution.—Germany. Galicia and Austria. Sweden. Bornholm. N. Russia. Manchuria. Central China. Japan. Ceylon. Java. Australia. New Zealand. Nova Scotia. United States. Porto Rico. Colombia. Brazil. Paraguay. Patagonia.

Var. **trigranulatum** W. & G. S. West. (Pl. CLX, fig. 8.)

Sph. granulatum var. *trigranulatum* West & G. S. West, Alg. N. Ireland, 1902, p. 59, t. 2, f. 18.

Cells slightly longer than in the type; semicells with 3 granules only on each side, arranged in a vertical series on the lateral margin.

Length 10·2–11·3 μ; breadth 10·6 μ; thickness 5·8 μ; breadth of isthmus 5 μ.

IRELAND.—Gortahork, Donegal!

5. Sphærozosma Wallichii Jacobs.

(Pl. CLX, fig. 9.)

Sphærozosma excavatum β Wallich, Desm. Low. Bengal, 1860, p. 192, t. 7, f. 15.

Sph. Wallichii Jacobs. Desm. Danem. 1875, p. 211; ? Wolle, Desm. U. S. 1884, p. 30, t. 4, f. 15; De Toni, Syll. Alg. 1889, p. 794; Turn. Alg. E. India, 1893, p. 141, t. 18, f. 1, 12, 13; Johns. New Rare Desm. 1894, p. 286; West & G. S. West, Desm. U. S. 1898, p. 320; Borge, Alg. erst. Regnell. Exped. II, Desm. 1903, p. 121.

Sph. excavatum β *Wallichii* Nordst. in Pointsf. Skandin. Växt. 4, 1880, p. 24.

Sph. Regnesi Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 21–23, t. 1, f. 12.

Cells small, slightly broader than long, constriction fairly deep, sinus oval in shape, semicells narrowly oblong, angular, sides truncate with a granule at each angle, apex slightly convex; semicells with 2 granules placed symmetrically on each broad face; cells in lateral view very slightly constricted, semicells rounded, with 2 granules in a vertical series.

Zygospore unknown.

Length 15–16 μ; breadth 16–17 μ; thickness 8 μ; breadth of isthmus 6–7 μ.

SCOTLAND.—Inverness, Aberdeen and Kincardine (*Roy & Biss.*).

Geogr. Distribution.—Sweden. Denmark. Bengal. Australia (form). United States. Brazil (form).

Var. **anglicum** W. & G. S. West. (Pl. CLX, figs. 10, 11.)

Sph. Wallichii var. *anglicum* West & G. S. West, Alg. S. England, 1897, p. 497, t. 6, f. 6.

Apex of semicell slightly convex, sinus smaller than in the type, with 2 or 3 granules on the lateral margins of the semicells, and others scattered sparsely and irregularly across the surface.

Length 10–11·5 μ; breadth 10·5–11 μ; breadth of isthmus 6 μ; thickness 5·5 μ.

ENGLAND.—New Forest, Hants! (Abundant July, 1897.)

Genus 22. **ONYCHONEMA** Wallich, 1860.

Wallich, Desm. Low. Bengal, 1860, p. 194.
Cooke, Brit. Desm. 1887, p. 6.
De Toni, Syll. Alg. 1889, p. 795.
Wille in Engl. Naturl. Pflanz. Fam. 1890, p. 14.
Turn. Freshw. Alg. E. India, 1893.
G. S. West, Brit. Freshw. Alg. 1904, p. 175.

Cells small, forming simple filamentous colonies, compressed, deeply constricted, sinus narrow; semicells elliptic or reniform, sometimes with strong lateral

spines; each semicell with 2 capitate processes of considerable length projecting from its apex; processes disposed asymmetrically, and overlapping the adjacent cell. Chloroplasts axile, one in each semicell, with a central pyrenoid. Filaments long and twisted, and often embedded in a mucous investment.

Zygospores only known in one species, globose, with many simple spines.

The genus *Onychonema* is closely allied to *Sphærozosma*, from which genus it differs in the size and arrangement of its apical processes. In *Onychonema* the two processes of each semicell do not apply themselves to the processes of the neighbouring semicell, but overlap it in a characteristic way, so that in the front view, all the processes on the left of the filament are disposed in one direction, and all those on the right in the opposite direction.

As in *Sphærozosma*, Lütkemüller (in 'Zellmembr. Desm.' 1902, p. 367) has expressed his doubts that these apical processes are really for the purpose of attaching the cells together, and has demonstrated the presence of two cushions of jelly, closely in contact, filling up the space between the cells (in *Onychonema filiforme*), which he considered to be the real agents in effecting the attachment. As in *Sphærozosma* also, he suggests that their real function is to counteract the tendency of the filaments to twist, a tendency present in an almost dangerous degree.

Both species of *Onychonema* are very rare.

1. **Onychonema filiforme** (Ehr.) R. & B.

(Pl. CLX, figs. 13, 14.)

Tessararthra filiformis Ehr. Inf. 1838, t. 10, f. 21.
? *Odontella filiformis* Ehr. Inf. 1838, p 154.
Isthmia filiformis Menegh. Synops. Desm. p. 205.
Isthmosira filiformis Kütz. Phyc. Germ. 1845, p. 141; Spec. Alg. 1849, p. 188.
Sphærozosma filiformis ? Ralfs, Brit. Desm. 1848, p. 209; Arch. in Pritch. Inf. 1861, p. 724; Rabenh. Flor. Eur. Alg. 1868, p. 149; Arch. in Quart. Journ. Micr. Sci. v. 9, 1869, p. 198; Lund. Desm. Suec. 1871, p. 91; Kirchn. Alg. Schles. 1878, p. 133; Wolle, Desm. U. S. 1884, p. 29, t. 4, f. 5, 6; Cooke, Brit. Desm. 1887, p. 5, t. 2, f. 6; Hansg. Prodr. Alg. Böhm. 1888, p. 170; Comère, Desm. de France, 1901, p. 199, t. 16, f. 6.
Onychonema Nordstedtianum Turn. New Rare Desm. 1885, p. 934, t. 15, f. 3; Cooke, Brit. Desm. 1887, p. 6, t. 2, f. 7; Nordst. Desm. Bornh. 1888, p. 208; De Toni, Syll. Alg. 1889, p. 796; West, Alg. N. Wales, 1890, p. 7; Turn. Alg. E. Ind. 1893, p. 139, t. 17, f. 17; Roy & Biss.

Scott. Desm. 1893, p. 11; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. N. Ireland, 1902, p. 59; G. S. West, Brit. Freshw. Alg. 1904, p. 175, f. 67, G, H.

Onychonema filiforme Roy & Biss. Jap. Desm. 1886, p. 242; Nordst. Freshw. Alg. New Zeal. 1888, p. 29, t. 2, f. 10; De Toni, Syll. Alg. 1889, p. 786; Anders. Sverig. Chloroph. 1890, p. 9; West, Notes Dan. Alg. 1891, p. 1; West, Alg. W. Ireland, 1892, p. 116; Alg. Eng. Lake Distr. 1892, p. 6; Roy & Biss. Scott. Desm. 1893, p. 11; West & G. S. West, Alg. S. England, 1897, p. 497; G. S. West, Brit. Freshw. Alg. 1904, p. 175; Kaiser, Alg. Traunstein u. Chiem. 1914, p. 153.

Sphærozosma vertebratum Hauptfl. Zellm. u. Hullgallerte Desm. 1888, p. 21 (sep.), t. 2, f. 16–23, 27.

Cells small, about as long as broad, deeply constricted, sinus narrow, almost linear; semicells elliptical or subreniform, ventral margin almost straight, dorsal margin broadly rounded; semicells with two long processes, nearly as long as the semicell itself; disposed asymmetrically, and overlapping the adjacent cell of the filament (only one of the processes of any semicell is seen in the front view, the second one being on the opposite side of the filament). Cells united to form long twisting filaments, the cells often separated from each other by a greater or smaller space.

Zygospore unknown.

Length, not including processes, 9–12·5 μ; breadth 10–12·5 μ; thickness 5–6·4 μ; breadth of isthmus 3·5–4 μ.

England.—Bowness, Westmoreland! Pilmoor and Strensall Common (*W. B. Turn.*), N. Yorks! Skipwith and Riccall Commons, E. Yorks! Dartmoor, Devon (*Harris*). Gunwen Moor, Cornwall!

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Near Strathpeffer, Ross; Lochs Ruthven, Aschie, Coire, near Brin, Inverness; Aberdeen and Kincardine (*Roy & Biss.*). Rhiconich, Sutherland!

Ireland.—Near Glenties and Lough Anna, Donegal! Roundstone, Mayo! Lakes near Recess, Clifden and Derryclare Lough, Galway! Tipperary (*Arch.*). Ulster, Munster and Connaught (*Adams*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Sweden. Denmark. Bornholm. Poland. Japan. Celebes. India. New Zealand. Australia. Tasmania. United States. Colombia.

After very careful consideration the writer has failed to find any essential differences between *O. filiforme* (Ehr.) R. & B. and *O. Nordstedtianum* Turn. Only one difference seems to have been recognised by earlier writers, namely, that *O. filiforme* has larger or smaller spaces between the adjacent cells of the filament, whilst in *O. Nordstedtianum* adjacent cells are contiguous with one another. As Lütkemüller ('Zellm. Desm.' 1902, p. 367) has shown, however, the cells are actually separated by gelatinous cushions, and it is presumably the size of these which determines the spacing of the cells. It is improbable that specific distinctions can be based on such a character, and it has therefore been deemed better to unite the two under the older name of *O. filiforme* (Ehr.) R. & B.

2. **Onychonema læve** Nordst.

(Pl. CLX, figs. 15, 16.)

Onychonema læve Nordst. Desm. Brasil, 1870, p. 206, t. 3, f. 34; Reinsch, Contrib. Fung. et Alg. 1875, p. 93, t. 15, f. 4; De Toni, Syll. Alg. 1889, p. 796; Turn. Freshw. Alg. E. India, 1893, p. 139, t. 17, f. 15A; Roy & Biss. Scott. Desm. 1893, p. 11; Racib. Desm. Tapakoomas, 1895, p. 32; West & G. S. West, Alg. Ceylon, 1902, p. 193; Alg. Burma, 1907, p. 224, t. 12, f. 8–10.

Xanthidiastrum paradoxum Delp. Spec. Desm. Subalp. 1877, p. 80, t. 3, f. 27–33.

Cells larger than in *O. filiforme*, slightly broader than long, deeply constricted, sinus narrow for part of its length, dilated at the apex, and opening widely; semicells oblong or subreniform, attenuated towards the lateral angles and ending in a long stout converging spine; apical processes rather shorter than the spines; vertical view elliptic, drawn out into a spine at the two poles. Filaments usually embedded in a mucous investment.

Zygospores spherical, with many short, stout, simple spines.

Length 16–17 μ; breadth, without spines, 20·5–25 μ; including spines, 25–46 μ; breadth of isthmus 6 μ; diam. zygosp., without spines, 17–20 μ; with spines, 24–26 μ.

SCOTLAND.—Found once by the side of the old road from Aboyne to Kincardine O'Neil, about a mile from Aboyne, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Japan (var.). India. Ceylon. Burma. Java. Australia. East and Central Africa (var.). United States. W. Indies (var.). Guiana. Brazil. Paraguay (var.).

This species is very rare in Britain, and indeed in the whole of Europe. There is only the one record of it for the British Isles.

The spore figured on Pl. CLX, fig. 16 is peculiar in having been produced apparently from a single cell. The authors of this Monograph were undecided whether it should be considered a true zygospore or an aplanospore. In its external form it is essentially similar to the zygospore of the variety *micracanthum* of this species (see Pl. CLX, fig. 17). This variety is rather more frequent than the type form, though it does not occur in North Temperate regions. The normal zygospore of the typical form has not yet been observed.

Genus 23. **SPONDYLOSIUM** Bréb. 1844.

Bréb. in Dict. univ. hist. nat. 4, 1844, p. 711 (*Spondylotium*).
Kütz. Spec. Alg. 1849, p. 189.
De Bary, Conj. 1858, p. 76.
Arch. in Pritch. Inf. 1861, p. 724.
Kirchn. Alg. Schles. 1878, p. 133.
De Toni, Syll. Alg. 1889, p. 792.
Wille in Engler, Naturl. Pflanzenfam. 1890, p. 14.
Turn. Freshw. Alg. E. India, 1893, p. 47.
G. S. West, Brit. Freshw. Alg. 1904, p. 175.
Leuronema Wallich, Desm. Low. Bengal, 1860, p. 193.

Cells usually small, or of medium size, flattened and often deeply constricted with a narrow or open sinus; semicells variable in shape, often with broadly truncate or concave apices; in vertical view elliptical, triangular or trilobed; chloroplasts axile. Cells united to form long filamentous colonies by the simple close apposition of their apices, sometimes twisted and often enveloped in mucilage. In one species the filaments are often observed attached to other aquatic plants by means of a short basal gelatinous cushion.

Zygospores usually globose and smooth, or with simple spines. Lateral conjugation through the apices

of the cells of the filament has been observed in one instance.

The genus *Spondylosium* is very closely allied to *Sphærozosma*, the sole distinguishing feature being the absence of the short apical processes between the cells which are characteristic of the latter genus.

All the British species are comparatively rare, and do not commonly occur in abundance. They may be arranged as follows :—

* Semicells elliptical or subelliptical.
† Apex of semicell straight or slightly convex, never concave.
1. *Sp. pygmæum.*
2. *Sp. ellipticum.*
3. *Sp. planum.*
4. *Sp. papillosum.*
5. *Sp. Lundellii.*

†† Apex of semicell distinctly concave.
6. *Sp. secedens.*

** Cells more or less rectangular ; sinus a very shallow excavation.
7. *Sp. tetragonum.*

*** Semicells truncate-pyramidate.
8. *Sp. pulchellum.*

1. **Spondylosium pygmæum** (Cooke) West.

(Pl. CLX, figs. 18, 19.)

Sphærozosma pygmæum Cooke, Brit. Desm. 1887, p. 5, t. 2. f. 5. [This is not *Sph. pygmæum* Rabenh.] West, Alg. N. Wales, 1890, p. 6.
Spondylosium pygmæum West, Freshw. Alg. W. Ireland, 1892, p. 116 (*Sphærozosma* by printer's error); West & G. S. West, Rec. publ. Desm. 1895, p. 65; Alga-fl. Yorks. 1902, p. 95.

Cells minute, about as long as broad, sometimes slightly broader than long, deeply constricted, sinus acute, almost linear for part of its length ; semicells elliptical, united by a relatively small surface of their apices to form long filamentous colonies, frequently enclosed in a gelatinous investment ; cell-wall smooth ; vertical view subelliptic.

Zygospore unknown.

Length 5–8 μ; breadth 5–8 μ; breadth of isthmus 2·5–3·2 μ.

ENGLAND.—Mickle Fell, N. Yorks! Riccall Common, E. Yorks! Dartmoor, Devon (*Harris*).

WALES.—Capel Curig, and Dolbadarn Castle, Carnarvonshire! Barmouth, Merioneth (*Cooke*).

IRELAND.—Connaught (*Adams*).

Geogr. Distribution.—Germany. Switzerland. Roumania. Norway. S. Africa (var.). Azores.

Some confusion has arisen with regard to this species, owing to the fact that Cooke was under the impression that his *Sphærozosma pygmæum* was equivalent to the species described under that name in Rabenh. 'Flor. Europ. Alg.' 1868, p. 150. This is not so, however, for *Sphærozosma pygmæum* Rabenh. is the same as *Cosmarium pygmæum* Arch., which is a true *Cosmarium*, and has nothing at all to do with the filamentous Desmids [*vide* Vol. III, p. 73].

Var. **monile** (Turn.) *nob.* (Pl. CLX, figs. 20, 21.)

Spondylosium monile Turn. Desm. Notes, 1893, p. 346, f. 19. [Side view inaccurate.]
Sp. pygmæum var. *monile* W. & G. S. West in manuscript.

Cells relatively longer than in the type, semicells more broadly oval, semiglobular; cells in side view gently constricted in the middle.

Length about 7 μ; breadth about 4 μ; thickness about 3 μ.

WALES.—Trelleck Common, Monmouth (*Turn.*).

IRELAND.—Westport, Mayo!

Var. **compressum** West. (Pl. CLX, fig. 22.)

Sp. pygmæum var. *compressum* West, Alg. Engl. Lake Distr. 1892, p. 6, f. 4.

Cells in outline subquadrangular, sinus linear, semicells compressed, oblong, with their apices flattened.

Length 5·5–6 μ; breadth 7 μ; breadth of isthmus 2·5 μ.

ENGLAND.—Brother's Water, Westmoreland!

2. **Spondylosium ellipticum** W. & G. S. West.

(Pl. CLXI, fig. 15.)

Spondylosium ellipticum West & G. S. West, Alg. N. Ireland, 1902, p. 43, t. 2, f. 21.

Cells of medium size, about as long as broad, deeply constricted, sinus open and acute; semicells exactly elliptical, apices convex, not flattened; semicells in side view subspherical; from the end, elliptical; chloroplasts one in each semicell with a central pyrenoid. Cells forming twisted colonies, with no mucous sheath.

Zygospore unknown.

Length 19·6–24 μ; breadth 20–22 μ; thickness 11·5–12 μ; breadth of isthmus 6·7–7 μ.

IRELAND.—Lough Fea, Londonderry!

This species approaches *S. ovale*, Turn. (in 'Alg. E. Ind.' 1893, p. 44, t. 18, f. 3, 9), but it is distinguished by its smaller size, its relatively longer cells, its much deeper constriction, and by the perfectly elliptical semicells. It is also more deeply constricted in the side view than *S. ovale*, and only one pyrenoid is present in a semicell.

It also resembles to a certain extent *S. planum* (Wolle) W. & G. S. West, but the more depressed semicells of the latter species distinguish it.

3. **Spondylosium planum** (Wolle) W. & G. S. West.

(Pl. CLX, figs. 23–25.)

Sphærozosma pulchrum var. *planum* Wolle, Desm. U. S. 1884, p. 29, t. 4, f. 3, 4; De Toni, Syll. Alg. 1889, p. 794.

Spondylosium ovale Turn. Alg. E. India, 1893, p. 44, t. 18, f. 3, 9.

Sp. pulchrum var. *planum* W. & G. S. West, Obs. Conj. 1898, p. 54; Scott. Freshw. Plankt. I, 1903, p. 551.

Sp. planum W. & G. S. West, Periodic. Phytopl. Brit. Lakes, 1912, p. 430, t. 19, f. 5–8.

Cells of medium size, about $1\frac{1}{6}$ times broader than long, subquadrangular, angles rounded, deeply constricted, sinus obtuse, open; semicells transversely oblong, angles broadly rounded, apices flat; in vertical view oblong with rounded ends; from the side sub-

circular; cell-wall smooth; cells united into filaments, not twisted, and destitute of a gelatinous sheath.

Zygospores have been recorded, but without description.*

Length 11·5–19·5 μ; breadth 12–25 μ; thickness 6–11 μ; breadth of isthmus 5–11·5 μ.

England.—Plankton of Crummock Water, Derwent Water, Bassenthwaite Water, and Thirlmere, Cumberland! Plankton of Red Tarn, Ullswater, Hawes Water, Grasmere and Windermere, Westmoreland!

Wales.—Llyn Ogwen, Carnarvonshire!

Scotland.—Plankton of Lochs nan Cuinne and Shin, Sutherland!, of Lochs Luichart and Rosque, Ross!, of Lochs Tay, Katrine, and Achray, Perth!, and Loch Cuthaig, Lewis, Outer Hebrides!

Ireland.—Plankton of Mayo!, Galway! and Kerry!

Geogr. Distribution.—Norway. United States and Alaska. Canada.

This species, considered for a long time to be a variety of *Sp. pulchrum* (Bail.) Arch., was finally given specific rank in view of its constant and distinctive characters. There is no possibility of confusing it with any other species of *Spondylosium*, and it has little, if any, relationship with *Sp. pulchrum*, differing in its much smaller size, in its plane untwisted filaments, and in the flattened closely applied apices of the semicells. The semicells are of a different form from those of *Sp. pulchrum*, and the cells are proportionately longer. It is a common species in the plankton of many British lakes.

4. **Spondylosium papillosum** W. & G. S. West.
(Pl. CLXI, figs. 6, 7.)

Sphærozosma depressum West, Alg. N. Wales, 1890, p. 7; Schmidle, Alg. Bern. Alp. 1894, p. 87; Beitr. Alp. Alg. 1895, p. 9.

Spondylosium depressum Kirchn. Micr. Pflanz. Süssw. 1891, p. 21, t. 2, f. 61.

Sp. papillosum W. & G. S. West, Alg. Mad. 1895, p. 43, t. 9, f. 19; Notes Alg. I, 1898, p. 5; Alga-fl. Yorks. 1902, p. 95; Alg. N. Ireland, 1902, p. 43; Notes Alg. III, 1903, p. 10; G. S. West, Brit. Freshw. Alg. 1904, p. 176, f. 67 B (*papillatum* in error).

Sphærozosma papillosum Schmidle, Alg. aus. Nyassa See, 1903, p. 75.

* Lateral conjugation is reported by W. & G. S. West in specimens from Maine ('Obs. Conj.' 1898, p. 54), but no description is given.

Cells very small, as long as or slightly longer than broad, constriction moderately deep, sinus obtuse and open; semicells elliptical, with truncate apices; lateral margins provided with 3 very minute granules; semicells in side view subcircular. Cells united to form twisted filaments, destitute of a gelatinous sheath.

Zygospore unknown.

Length 8–9·5 μ; breadth 8·5–9·5 μ; thickness 5 μ; breadth of isthmus 4–5·5 μ.

ENGLAND.—Skipwith Common, E. Yorks! Harborne, and in the plankton of Bracebridge Pool, Sutton Park, Warwickshire!

WALES.—Capel Curig, Dolbadarn Castle, near Llanberis, and Llyn-y-cwm-ffynon, Carnarvonshire!

SCOTLAND.—Rhiconich, Sutherland!

IRELAND.—Near Glenties, Donegal!

Geogr. Distribution.—Germany. Australia. Madagascar. Central and E. Africa. United States.

This species, which is nearest to *Sp. tetragonum* W. & G. S. West, is one of the least rare of the British species of *Spondylosium*, although being, at the same time, not at all common. Some confusion has arisen owing to the fact that it was not made clear in the older compilations of Rabenhorst and De Toni, whether the protuberances of *Sp. depressum* Bréb. are apical or lateral in position. In true *Sp. depressum* Bréb. they are, of course, apical. This species has never been found in Britain. The looseness of these descriptions led to a form identical with *Sp. papillosum* West being figured by Kirchner ('Micr. Pflanz. Süssw.' 1891, p. 21, t. 2, f. 61) as *Sp. depressum*. Thus *Sp. papillosum* W. & G. S. West embraces *Sp. depressum* Kirchn., but not Bréb.

5. **Spondylosium Lundellii** Borge.

Spondylosium pulchrum forma Lund. Desm. Suec. 1871, p. 93, t. 5, f. 17; Delp. Spec. Desm. subalp. 1877, p. 77, t. 3, f. 11.
Sp. Lundellii Borge, Sao Paulo Alg. 1919 p. 71, t. 6, f. 6.

Cells of medium size, about $1\frac{1}{2}$ times broader than long, constriction not deep, sinus acute, opening widely; semi-

cells oblong, with rounded ends, apex convex, but flattened on the top ; in lateral view with rounded sides ; vertical view subrectangular, sides nearly straight or very slightly convex, ends rounded and produced, and asymmetrical, there being a slight concavity on the right side of the one produced end, and on the left side of the other. Cells united into long twisting filaments.

Zygospore unknown.

Length 18·5–20 μ ; breadth 28–33 μ ; thickness 16–19 μ ; breadth of isthmus 20–24·5 μ.

Geogr. Distribution.—Sweden. Italy.

Var. **triquetrum** (Lund.) nob. (Pl. CLXVII, fig. 10.)

Sp. pulchrum var. *triquetrum* Lund. Desm. Suec. 1871, p. 93 ; West, Alg. W. Ireland, 1892, p. 116, t. 19, f. 3.

Cells in vertical view triangular, angles obliquely rounded-truncate ; chloroplast axile with a central pyrenoid.

Length 20–24 μ ; breadth 28–36 μ ; breadth of isthmus 22–27 μ.

IRELAND.—Lakes, Clifden to Roundstone, Galway !

Geogr. Distribution.—Sweden.

6. **Spondylosium secedens** (De Bary) Arch. (Pl. CLXI, figs. 8–11.)

Sphærozosma secedens De Bary, Conj. 1858, p. 76, t. 4, f. 35–37 ; Rabenh. Flor. Europ. Alg. 1868, p. 150 ; Cooke, Brit. Desm. 1887, p. 5, t. 2, f. 3 ; Hansg. Prod. Alg. Böhm. 1888, p. 170 ; De Toni, Syll. Alg. 1889, p. 792 ; Roy & Biss. Scott. Desm. 1893, p. 10 ; Lütkem. Desm. Millstättersees 1900, p. 82, t. 1, f. 1–5.

Spondylosium secedens Arch. in Pritch. Inf. 1861, pp. 719, 724 ; in Quart. Journ. Micr. Sc. 1871, p. 92 ; Eichler, Mater. Flor. Miedz. 1895, p. 57 ; West & G. S. West, Alga-fl. Yorks. 1902, p. 95 ; Alg. N. Ireland, 1902, p. 43, t. 2, f. 19, 20.

Sphærozosma excavatum var. *secedens* Rabenh. Krypt.-fl. Sachs. 1863, p. 178.

Sph. pygmæum Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, t. 2, f. 24–26, 30.

Cells small, about as long as broad, but sometimes slightly longer or shorter, constriction moderately deep, sinus open and obtuse ; semicells subelliptical ; lateral angles rounded, ventral margin slightly convex, dorsal margin primarily strongly convex, but with a conspicuous

deep concavity in the middle. Cells attached together by the projecting parts of the apices to form fragile filaments, which readily break. Filaments destitute of a mucous sheath; cell-wall smooth.

Zygospore globose, provided with simple straight spines; rarely irregularly angular, with the angles produced.

Length 8·5–12 μ; breadth 7·5–10 μ; thickness 5–6 μ; breadth of isthmus 3·5–6 μ; diam. zygosp. without spines 9–10 μ; with spines, 15–16 μ.

England.—Bog 2 m. S. of Clapham, W. Yorks! Enbridge Lake, Hants (*Roy*).

Ireland.—Near Glenties, Donegal! Kylemore, Galway (*Arch.*). Slieve Donard, Down! Shores of Lough Neagh.

Scotland.—Slewdrum, Loch Dawan, and Mosston Moor in Cromar, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Germany. Galicia and Austria. Spain. Scandinavia. Poland. Australia.

7. **Spondylosium tetragonum** West.

(Pl. CLXI, figs. 12–14.)

Sphærozosma (Spondylosium) pulchellum Gay, Monogr. loc. Conj. 1884, p. 79, t. 3, f. 1.
? *Sph. bambusinoides* Heimerl, Desm. alpin. p. 589, t. 5, f. 1 (form).
Spondylosium tetragonum West, Alg. W. Ireland, 1892, p. 115, t. 19, f. 2; West & G. S. West, Rec. publ. Desm. 1895, p. 65; Freshw. Alg. Columbia, 1912, p. 1046, t. 23, f. 55–57.
Sp. Treubii Bernard. Alg. unicell. domaine Malais, 1909, p. 21, t. 1, f. 16.

Cells minute, slightly longer than broad, slightly and broadly excavated at the isthmus, sides rounded, apex of semicells truncate; in vertical view elliptical; in side view oblong, very slightly constricted. Cells united into twisted colonies, destitute of a mucous sheath.

Zygospore unknown.

Length 8·5–10 μ; breadth 10 μ; thickness 6 μ; breadth of isthmus 8 μ.

Ireland.—Kylemore, Galway!

Geogr. Distribution.—France. Switzerland. Finland. Java. Colombia.

8. **Spondylosium pulchellum** Arch.
(Pl. CLXI, figs. 1–3.)

Sphærozosma pulchellum Arch. Suppl. Cat. Desm. 1858, p. 253, t. 21, f. 7; Rabenh. Flor. Europ. Alg. 1868, p. 150; Cooke, Brit. Desm. 1887, p. 6, t. 2, f. 4; Maskell, Further Notes N. Zeal. Desm. 1888, p. 9, t. 1, f. 2; De Toni, Syll. Alg. 1889, p. 792; West, Alg. N. Wales, 1890, p. 7; Comère, Desm. de France, 1901, p. 199, t. 16, f. 8.
Spondylosium pulchellum Arch. in Pritch. Inf. 1861, p. 724, t. 3, f. 10; in Quart. Journ. Micr. Sci. 1866, p. 120; Nordst. Norges Desm. 1873, p. 47; Arch. in Quart. Journ. Micr. Sci. 1877, p. 191; Kirchn. Alg. Schles. 1878, p. 134; Anderss. Sverig. Chlor. 1890, p. 9; West, Alg. W. Ireland, 1892, p. 115; Roy & Biss. Scott. Desm. 1893, p. 10; West & G. S. West, Alg. S. England, 1897, p. 492; Alga-fl. Yorks. 1902, p. 95; Alg. N. Ireland, 1902, p. 42; G. S. West, Brit. Freshw. Alg. 1904, p. 176, f. 67 A; West & G. S. West, Alg. Orkneys & Shetlands, 1905, p. 28.
Sphærozosma secedens var. *pulchellum* Hansg. Prodr. Alg. Böhm. 1888, p. 170.

Cells very small, about as long as broad, sometimes longer than broad, constriction fairly deep, sinus linear; semicells truncate-pyramidate, inflated at the base, apex broad and flat, upper angles sharp, almost rectangular; lower angles broadly rounded; sides gently concave; semicells in side view subcircular; in end view elliptical; filaments often long, not twisted, frequently found attached by a short thick gelatinous stalk to other aquatic plants.

Zygospore unknown.

Length 12–15 μ; breadth 10–11 μ; breadth of apex 5 μ; breadth of isthmus 4·5–6 μ.

England.—Harrop Tarn, Cumberland! Grisedale Tarn, Westmoreland! Adel, W. Yorks, and Strensall, N. Yorks (*W. B. Turn.*). Skipwith and Riccall Commons, E. Yorks! Grimspound! and Dartmoor (*Harris*), Devonshire.

Wales.—Snowdon!, Moel Siabod!, and Capel Curig (*Cooke & Wills*), Carnarvonshire.

Scotland.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth! and Argyle (*Roy & Biss.*). Sutherland! Hoy, Orkneys!

Ireland.—Donegal! Mayo! Galway! Kerry! Lough Neagh! Ulster, Munster, Leinster and Connaught (*Adams*).

Geogr. Distribution.—France. Germany. Galicia and

Austria. Hungary. Norway. Sweden. Denmark. N. and S. Russia. Greenland. New Zealand (var.). United States.

Several investigators have noticed that this tiny species sometimes occurs attached to filamentous algæ, or to the leaves of mosses, by means of a very short gelatinous basal stalk. It is the only species of the genus in which this is known to occur, and even here the filaments are so fragile and break away so easily from the basal attachment that it is usually observed in a free floating condition. The cells are all alike, and there is no distinction in their form, whether they are near the base or the apex of the filament. It seems to occur more abundantly in Ireland than in any other part of the British Isles.

Var. **pyramidatum** West. (Pl. CLXI, figs. 4, 5.)

Sp. pulchellum var. *pyramidatum* West & G. S. West, New Brit. Alg. 1893, p. 3, f. 8; Alga-fl. Yorks. 1902, p. 95.

Semicells more definitely pyramidate than in the type, sides nearly straight, apex broadly truncate; isthmus narrower than in the type.

Length 10–11 μ; breadth 8·6–9·6 μ: thickness 4·8 μ; breadth of apex 5·8–5·9 μ: breadth of isthmus 2–2·6 μ.

ENGLAND.—Riccall Common, E. Yorks.

SPECIES TO BE ENQUIRED INTO.

SPONDYLOSIUM ARMILLATUM Turn. 'Desm. Notes,' 1893, p. 346, f. 20. A still smaller plant (than *Spondylosium monile* Turn. = *Sp. pygmæum*, var. *monile* (Turn.) West), biscoctiform, centre gently incavate in front view; side view compressed. Length 6 μ; breadth 3·7 μ; thickness 2·5 μ—Trelleck Common, Monmouth, Wales.

Genus 24. **HYALOTHECA** Ehrenb. 1840.

Ehrenb. in Berlin. Monats. 1840, p. 212.
Kütz. Phyc. Germ. 1845, p. 140.
Ralfs, Brit. Desm. 1848, p. 51.
Kütz. Spec. Alg. 1849, p. 187.
De Bary, Conj. 1858, p. 76.

Arch. in Pritch. Inf. 1861, p. 722.
Rabenh. Flor. Europ. Alg. 1868, p. 151.
Delp. Spec. Desm. subalp. 1873, pp. 23, 47.
Wood, Freshw. Alg. N. Amer. 1873, p. 124.
Kirchn. Alg. Schles. 1878, p. 131.
Wolle, Desm. U. S. 1884, p. 22.
Cooke, Brit. Desm. 1887, p. 7.
De Toni, Syll. Alg. 1889, p. 785.
Wille in Engler Naturl. Pflanzenf. 1890, p. 16.
Comère, Desm. de France, 1901, p. 196.
G. S. West, Brit. Freshw. Alg. 1904, p. 176.

Cells subcylindrical, shorter or longer than broad, very slightly constricted, semicells trapezoid, subquadrate or oblong, with straight or slightly convex lateral margins; cells united by their broadly truncate apices to form long filamentous colonies, which are sometimes twisted and almost invariably enveloped in a gelatinous sheath of some thickness. Chloroplasts axile, one in each semicell, usually with a central pyrenoid, and several radiating ridges.

Zygospores globose, smooth, sometimes enclosed in an irregularly shaped structure consisting of the gametangia united by the broad conjugation tube. Prior to conjugation the filaments break up into individual cells.

Aplanospores are known in two species of the genus. They are formed from the ordinary cells by the rounding off of the cell contents, which then acquire a strong cell-wall of their own. The formation of aplanospores is also accompanied by the total or partial dissociation of the filament into individual cells.

The genus *Hyalotheca* is very closely allied to *Spondylosium*, from which it is distinguished by its extremely slight development of a sinus, and also by the usually circular outline of its cells in the vertical view. There are 5 British species only, of which one is abundant and universal in its distribution, whilst three are amongst the rarest of British Desmids.

1. **Hyalotheca dissiliens** (Sm.) Bréb.

(Pl. CLXI, figs. 16–27.)

Conferva dissiliens Smith, Engl. Botany, v. 35, 1812, t. 2464.
Desmidium mucosum Bréb. Alg. Falaise, 1835, p. 65, t. 2; Menegh. Synops Desm. 1840, p. 4; Ralfs in Ann. Mag. Nat. Hist. 1843, p. 374, t. 8, f. 2.
Glœoprium dissiliens Hass. Brit. Freshw. Alg. 1845, p. 346, t. 83, f. 34.

Hyalotheca dissiliens (Sm.) Bréb. in Ralfs, Brit. Desm. 1848, p. 51, t. I, f. 1; Bréb. Liste Desm. 1856, p. 118; De Bary, Conj. 1858, p. 76; Wallich, Desm. low. Bengal, 1860, p. 187; Arch. in Pritch. Inf. 1861, p. 722, t. 2, f. 32, 35; Rabenh. Krypt.-fl. Sachs. 1863, p. 179; De Notaris, Desm. Ital. 1867, p. 25, t. 1, f. 1; Reinsch, Alg. Frank. 1867, p. 203; Rabenh. Flor. Europ. Alg. 1868, p. 152; Wood, Freshw. Alg. N. Amer. 1873, p. 124, t. 12, f. 12; Delp. Spec. Desm. subalp. 1877, p. 47; Kirchn. Alg. Schles. 1878, p. 131; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 61; Gay, Mono. loc. Conj. 1884, p. 79; Wolle, Desm. U. S. 1884, p. 22, t. 1, f. 3–12, t. 24, f. 26; Lagerh. Bidr. Amer. Desm.-fl. 1885, p. 228; Cooke, Brit. Desm. 1887, p. 7, t. 3, f. 1; Hansg. Prodr. Alg. Böhm. 1888, p. 168; Boldt, Desm. Grön. 1888, p. 43, t. 2, f. 53; De Toni, Syll. Alg. 1889, p. 785; Wille in Engler, Natur. Pflanzenf. 1890, p. 15, f. 9; Heimerl, Desm. Alpin. 1891, p. 588; West, Alg. W. Ireland, 1892, p. 116; Alg. E. Lake Distr. 1892, p. 6; Roy & Biss. Scott. Desm. 1893, p. 9; Lütkem. Desm. Attersees, 1893, p. 538; Turn. Freshw. Alg. E. India, 1893, p. 151; Börg. Ferskv. Alg. Öst. Grönl. 1894, p. 32; Schröder, Beitr. Alg. Riesengebirges, 1897, p. 28; West & G. S. West, Alg. S. England, 1897, p. 497; G. S. West, Alga-fl. Cambs. 1899, p. 25; West & G. S. West, Furth. Contr. Alg. W. Indies, 1899, p. 284; Comère, Desm. France, 1901, p. 196, t. 16, f. 7; West & G. S. West, Freshw. Chlor. Koh Chang, 1901, p. 97; Alg.-fl. Yorks. 1902, p. 111; Alg. Ceylon, 1902, p. 195; Alg. N. Ireland, 1902, p. 60; Lütk. Zellm. Desm. 1902, p. 365, t. 18, f. 16, 29, 30; Borge, Alg. erst. Regn. Exped. II, 1903, p. 122; G. S. West, Brit. Freshw. Alg. 1904, p. 176, f. 68, A–D; West & G. S. West, Freshw. Alg. Orkneys & Shetlands, 1905, p. 28; Alg. Burma, 1907, p. 225, t. 12, f. 11–15; Borge, Botan. Notiser, 1911, p. 203; Kaiser, Alg. Traunstein Chiemgau, 1914, p. 153; Acton, *Hyalotheca dissiliens*, 1916, p. 379.

H. mucosa Kütz. Spec. Alg. 1849, p. 187.

Cells of medium size, about $1\frac{1}{4}$ times broader than long; constriction extremely small, consisting of a very slight concavity in the middle of the lateral margins; cells united by their apices to form long slimy filaments, constricted at the joints; apex of semicells broadly truncate, about as broad as the isthmus, lateral margins slightly convex; vertical view circular, sometimes with 2 opposite papillæ, or 3, equidistant (see formæ *bidentula* and *tridentula*, infra). Chloroplasts axile, one in each semicell, with a central pyrenoid and a number of radiating ridges, star-like in the vertical view. Filaments usually enveloped in a conspicuous gelatinous sheath, often as broad as the filament itself.

Zygospores produced after the dissociation of the filaments into isolated cells, spherical or rounded-oblong, smooth, contained in the swollen conjugation tube, to which the gametangia remain attached.

Length 10–33 μ; breadth 10–39 μ; diam. zygosp. 15–25 μ.

England.—Cumberland! and in the plankton of Ennerdale and Derwent Water! Westmoreland! (at 2400 feet on Helvellyn) and in the plankton of Brother's Water and of Codale, Easedale, and Red Tarns. Lancashire (*Ralfs*). W., N., and E. Yorks. Cheshire and Leicester (*Roy*). Suffolk! Essex! Cambs! Berks! Warwicks! (*Wills*). Worcs! Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Kent! Hants! Wilts! Devon! (*Harris*). Cornwall!

Wales.—Common! (zygospores common and up to 2200 feet on Glyder Fach, and at 2700 feet on Glyder Fawr.

Scotland.—General! and in the plankton! Wigtown (with zygospores)! Lewis and Harris, Outer Hebrides! Orkneys and Shetlands!

Ireland.—Common! Zygospores abundant! In the plankton, Mayo!, Galway and Kerry!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Hungary. Roumania. Turkey. Italy. Portugal. Norway. Finmark. Sweden. Denmark. Bornholm. Finland. Poland. N., S., and Central Russia. Faeroes. Nova Zembla. Spitzbergen. Greenland. Siberia. Central China. India. Ceylon. Burma. Siam. Singapore. Java. Australia. E. and Central Africa. Azores. United States. N. W. Canada. W. Indies. Guiana. Colombia. Brazil. Paraguay. Argentine.

H. dissiliens is one of the most ubiquitous of Desmids, and often occurs in great abundance. It is generally distributed in bogs and ditches, is not infrequent in plankton, and is often found conjugated. The zygospores also occur as a rule in great numbers. The broad gelatinous sheath which is almost invariably present is secreted by special pores in the cell-wall, which are crowded together in a broad band on the lateral walls of each semicell. The external aperture of these pores is often closed by a hardened gelatinous structure which renders them conspicuous, so that the wall appears to be punctate or finely granulate. This punctate appearance has been noted by several observers, but it is only due to phenomenon of jelly-secretion. The end cell of the filament has its free end also covered with

gelatinous material, which is secreted by a similar group of pores in the middle part of the apex.

Aplanospores have been observed in this species in material from Burma (f. *bidentula* and *tridentula*); *vide* W. & G. S. West, 'Alg. Burma,' 1907, p. 225, t. 12, f. 11–15. Their formation is preceded by the dissociation of the filaments into individual cells. The cells then increase their volume by a growth in length, becoming ultimately as long as broad. The chloroplasts soon show signs of disintegration, and then the entire protoplasmic mass assumes a spherical shape, becomes invested with a thick cell-wall, and forms a globular aplanospore. The increase in the length of the cell is often unequal, resulting in an asymmetrical mother-cell.

The zygospore is usually developed in the middle of the conjugation-tube between the two conjugating cells, but occasionally it may be formed nearer to the one gametangium than the other, or even entirely within one of them. In this case the gametangium nearer to or containing the zygote is considered ♀ (cf. *Desmidium cylindricum*, p. 251).

Delponte has distinguished 2 distinct forms of *H. dissiliens*.

A. var. *minor* Delp. Filaments usually naked, cells nearly as long as broad or slightly broader. Length of cells 18 μ; breadth 21 μ.

B. var. *major* Delp. Filaments usually with a sheath, cells $1\frac{1}{3}$ times broader than long, or even broader still. Length 27·2 μ; breadth 36 μ.

The only British record for var. *minor* is Capel Curig, N. Wales, and for var. *major*, Sutton Park, Warwicks., but it is almost certain that both are more widely distributed. The sheathless form of *H. dissiliens* does not commonly occur however.

The vertical view of the species varies in appearance, in consequence of which several forms are recognised. The typical form has an exactly circular vertical view, without projections of any kind, and is known as forma *circularis* Jacobs. ('Desm. Danem.' 1875, p. 212). Formæ *bidentula* and *tridentula* are as follows:—

Forma **bidentula** Nordst. (Pl. CLXI, figs. 20, 26.)

H. dissiliens f. *bidentula* Nordst. Norges Desm. 1873, p. 48, t. 1, f. 22; Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 228; Boldt, Desm. Grönl. 1888, p. 43; Nordst. Freshw. Alg. N. Zealand, 1888, p. 27; Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, p. 8; t. 1, f. 5, 9–13, 14, 18, 22, 23, 26–29 and 30; West, Freshw. Alg. W. Ireland, 1892, p. 116; West, Alg. Engl.

Lake Distr. 1892, p. 6 (sep.); Roy & Biss. Scott. Desm. 1893, p. 9 (sep.); Borge, Sao Paulo Alg. 1918, p. 77.

The cells are provided with small inflations at the base of the semicells, which are seen best in the end view as prominences at the two opposite poles of the nearly circular cell.

Length 16–33 μ; breadth 21–36 μ; thickness 18–33 μ.

ENGLAND.—Near Ditton Farm, Surrey! Enbridge and Milford Lakes, Hants (*Roy*).

SCOTLAND.—Common (*Roy & Biss.*).

IRELAND.—Lough Guitane, Kerry!

Geogr. Distribution.—Germany. Switzerland. Galicia in Austria. Norway. Sweden. Finland. Nova Zembla. Spitzbergen. Greenland. Burma. New Zealand. Brazil.

This form is probably more general in the British Isles than would appear from the above localities given, but it is difficult to recognise except in the end view.

Forma **tridentula** Nordst. (Pl. CLXI, fig. 21.)

H. dissiliens f. *tridentula* Nordst. Norges Desm. 1873, p. 48, t. 1, f. 23; Boldt, Desm. Grönland, 1888, p. 43; Nordst. Freshw. Alg. N. Zealand, 1888, p. 27; Roy & Biss. Scott. Desm. 1893, p. 9; West & G. S. West, Alg. S. England, 1897, p. 497; Alga-fl. Yorks. 1902, p. 111; Alg. N. Ireland, 1902, p. 60; Alg. Orkneys and Shetlands, 1905, p. 28.
H. dissiliens f. *triquetra* Jacobs. Desm. Danem. 1875, p. 213, t. 8, f. 29.

Semicells with 3 small basal inflations visible as tiny mamillæ at equal distances in the end view.

Length 18–24 μ; breadth 26–37 μ.

ENGLAND.—Cronkley Fell, N. Yorks! Sutton Park, Warwicks! Esher West End Common, Surrey! Enbridge and Milford Lakes, Hants (*Roy*). Wilts! Halgavor and Lanlivery Moors, Cornwall!

SCOTLAND.—General! In the plankton! Lough near Cearnabahl, Lewis, Outer Hebrides! Shetlands!

IRELAND.—Donegal (zygospores from Lough Nacung)! Galway! Kerry!

Geogr. Distribution.—Galicia in Austria. Hungary. Italy. Portugal. Norway. Sweden. Finland. Spitzbergen. Greenland. India. Burma. New Zealand. Colombia. Argentine.

Var. **tatrica** Racib. (Pl. CLXII, fig. 19.)

H. dissiliens var. *tatrica* Racib. Nonn. Desm. Polon. 1885, p. 64, t. 14, f. 5; De Toni, Syll. Alg. 1889, p. 786; West, Alg. Engl. Lake Distr. 1892, p. 6 (sep.); Schröder, Alg. Versuchsteiche Schles. Fischereiv. Trachenberg. 1897, p. 28.

Cells nearly as long as broad, or even up to $1\frac{1}{4}$ times longer than broad. quadrangular, distinctly constricted at the middle: semicells about twice as broad as long, with convex sides: forming short filaments, destitute of a mucous sheath. Cells in end view either perfectly circular, or of the form *bidentula*.

Length 16–22 μ; breadth 16–20 μ;

England.—Hawkshead, Lancashire!

Geogr. Distribution.—Galicia in Austria. Poland. E. Africa.

Var. **hians** Wolle. (Pl. CLXII, figs. 16–18.)

H. dissiliens var. *hians* Wolle, Freshw. Alg. U. S. 1887, p. 21, t. 54, f. 14–16; De Toni, Syll. Alg. 1889, p. 786; West, Alg. W. Ireland, 1892, p. 116; Alg. Engl. Lake Distr. 1892, p. 6 (sep.); West & G. S. West, Alg. S. England, 1897, p. 497; Alga-fl. Yorks. 1902, p. 111; Alg. Ceylon, 1902, p. 195; Alg. N. Ireland, 1902, p. 60: Alg. Orkneys and Shetlands, 1905, p. 28; Borge, Sao Paulo Alg. 1918, p. 77.
H. Indica Turn. Alg. E. India, 1893, t. 19, f. 18 (only).

Filaments conspicuously constricted at the joints; cells usually much broader than long. lateral margins of cell very convex. with an acute median incision or notch; filaments enclosed in a sheath.

Length 12–22 μ: breadth at broadest part 20–32 μ; breadth at apex of semicell 15–24 μ; breadth of isthmus 18–26 μ.

England.—Westmoreland! Lancashire! Horton in Ribblesdale, W. Yorks! Great Shunnor and Cronkley Fells, N. Yorks! Esher West End Common, Surrey!

Scotland.—Lerwick, Shetlands!

Ireland.—Near Glenties, Donegal! Clifden, Galway!

Geogr. Distribution.—N. Russia. Ceylon. New Zealand. United States. W. Indies. Brazil.

The turgid cells, very much constricted at their points of union, and also with their prominent median incision, readily distinguish this variety from the typical form.

2. **Hyalotheca mucosa** (Mert.) Ehr.

(Pl. CLXII, figs. 1–4.)

Conferva mucosa Mert. in Dillwyn Brit. Confervæ, 1809, p. 46, t. B; Agardh, Syst. Alg. 1824, p. 90; Harv. in Hook. Br. Fl. 1833, p. 351.
?? *Actinocyclus variabilis* Corda in Alm. de Carlsbad, 1840, p. 198, t. ii, f. 11–14.
Hyalotheca mucosa Ehr. in Berlin Monatsb. 1840, p. 212; Ralfs, Brit. Desm. 1848, p. 53, t. 1, f. 2; Arch. in Pritch. Inf. 1861, p. 722; Rabenh. Krypt.-fl. Sachs. 1863, p. 179; De Not. Desm. Ital. 1867, p. 26, t. 1, f. 2; Reinsch, Alg. Frank. 1867, p. 204; Rabenh. Flor. Europ. Alg. 1868, p. 152; Nordst. Norges Desm. 1873, p. 48; Wood, Freshw. Alg. N. Amer. 1873, p. 124; Kirchn. Alg. Schles. 1878, p. 131; Lagerh. Bidr. Sverig. Desm. 1883, p. 54; Gay, Monogr. loc. Conj. 1884, p. 79, t. 3, f. 2; Wolle, Desm. U. S. 1884, p. 23, t. 1, f. 13; Racib. Non. Desm. Polon. 1885, p. 64; Lagerh. Bidr. Amerik. Desm. 1885, p. 228; Cooke, Brit. Desm. 1887, p. 8, t. 3, f. 2; Hansg. Prodr. Alg. Böhm. 1888, p. 168; Hauptfl. Zellm. u. Hullgallerte Desm. 1888, pp. 63, 104; De Toni, Syll. Alg. 1889, p. 787; West, Alg. N. Wales, 1890, p. 7; Alg. Engl. Lake Distr. 1892, p. 6; Alg. W. Ireland, 1892, p. 117; Roy & Biss. Scott. Desm. 1893, p. 9; West & G. S. West, Alg. S. England, 1897, p. 497; Borge, Süssw. Alg. S. Patagon. 1901, p. 17; West & G. S. West, Alga-fl. Yorks. 1902, p. 111; Alg. Orkneys and Shetlands, 1905, p. 28; Alg. Third Tanganyika Exped. 1907, p. 131, t. 4, f. 4, 5; Alg. Burma, 1907, p. 226.
Glœoprium mucosum Ralfs in Ann. Mag. Nat. Hist. v. 16, 1845, p. 11, t. 3, f. 6; Hass. Brit. Freshw. Alg. 1845, p. 347, t. 83, f. 5, 6.
Hyalotheca Ralfsii Kütz. Spec. Alg. 1849, p. 187.
Mixotænium armillare Delp. Spec. Desm. subalp. 1873, p. 50, t. 1, f. 13–19.

Cells of medium size, quadrangular, about as long as broad, or sometimes rather longer, cylindrical, usually without the faintest indication of a constriction in the normal resting cell, very slightly or not conspicuously constricted at the joints, each semicell with 2 parallel rings of tiny granules just beneath its apex; vertical view circular; chloroplasts axile, one in each semicell, each with a central pyrenoid and several radiating ridges; filament enclosed in a very massive gelatinous sheath, usually of greater thickness than in *H. dissiliens*.

Zygospore spherical, or oblong with rounded ends, membrane smooth and yellowish brown.

Length 16–22 μ; breadth 16–22 μ; diam. zygosp. 27–30 μ.

England.—Plankton of Ennerdale Water, Cumberland! Westmoreland, and in the plankton of Brother's Water, Grasmere, and Codale and Easedale Tarns! W. and N. Yorks! Essex and Herts (*Hassall*). War-

wicks! (*Wills*). Surrey! Sussex (*Ralfs*). Hants! (*Bennett*). Devon and Cornwall! (*Ralfs*).

WALES.—Llyn Padarn!, Dolbadarn Castle!, Llyn Idwal!, Llyn Ogwen! and Capel Curig! (*Cooke & Wills*), Carnarvonshire.

SCOTLAND.—Inverness!, Aberdeen, Kincardine, Perth! and Argyle (*Roy & Biss.*). Sutherland! Ross! Lewis and Harris, Outer Hebrides! Not uncommon in the plankton! Plankton of Bressay, Shetlands!

IRELAND.—Dungloe and Glenties, Donegal! Plankton of Mayo! Oughterard, Derryclare Lough and in plankton, Galway! Muckross, Glen Carragh and in plankton, Kerry! Carrantuohill, Cork! Dublin and Wicklow (*Arch.*). Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Italy. Spain. Portugal. Norway. Sweden. Bornholm. Finland. Poland. S. Russia. India. Australia. Central Africa. United States and Alaska. N. W. Canada. Guiana. Brazil. Patagonia.

This species, although neither so common nor so abundant as *H. dissiliens*, is fairly generally distributed in the British Isles. It is readily distinguished from the latter species by the entire absence of a constriction, its apical crown of minute granules, and by its usually thicker sheath.

According to Hauptfleisch, each tiny granule near the apex of the semicell has in its centre the mouth of a jelly-secreting pore, and it is by means of these pores that the broad tough sheath of the filament is produced. The apical surface of each semicell is also provided with similar pores, but the mouths of these are not protruded beyond the general level of the surface in the same way as the lateral ones.

Var. **minor** Roy & Biss. (Pl. CLXII, fig. 5.)

H. mucosa var. *minor* Roy & Biss. Scott. Desm. 1893, p. 9 (sep.); West & G. S. West, Alg. Ceylon, 1902, p. 195, t. 22, f. 26.

Cells relatively narrower than in the type; filaments about half the normal thickness.

Length 12·5–14·5 μ; breadth 9–12 μ.

SCOTLAND.—Birsemore Loch, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Ceylon.

3. **Hyalotheca Indica** Turn.

(Pl. CLXII, fig. 10.)

Hyalotheca Indica Turn. Freshw. Alg. E. India, 1893, p. 152, t. 22, f. 17 (not t. 19, f. 18, which is *H. dissiliens* var. *hians*); West & G. S. West, Alg. Ceylon, 1902, p. 195; Further Contrib. Plankton Scott. Lochs, 1905, p. 505, t. 6, f. 6.

Cells small, a little longer than broad, subcylindrical, very slightly broader in the middle than at the ends, with a small but acute median incision; apex of semicell broad and truncate; filaments not conspicuously excavated at the joints; in vertical view circular; chloroplasts axile, one in each semicell, each with a central pyrenoid. Filaments enclosed in a gelatinous sheath.

Zygospore unknown.

Length 10–15·5 μ; breadth 9–12 μ; breadth of apices 7·5–10 μ; breadth of isthmus 8–10 μ.

ENGLAND.—Plankton of Easedale Tarn, Westmoreland!

SCOTLAND.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

IRELAND.—Plankton of small lakes, Clifden to Roundstone, Galway!

Geogr. Distribution.—India. Ceylon. Java (var.).

This species bears a superficial resemblance to some forms of *H. dissiliens*. From var. *hians* Wolle of that species it is distinguished by the relatively broader apices of its cells, the filaments not being so conspicuously excavated at the joints, whilst from *H. dissiliens* var. *tatrica* Racib. it is distinguished by its smaller size, and by the different form of its constriction, which, even though very slight, is more abrupt than in that species. The British examples are somewhat larger than those from India and Ceylon.

4. **Hyalotheca neglecta** Racib.

(Pl. CLXII, figs. 11–15; Pl. CLXIII, figs. 1–4.)

Hyalotheca neglecta Racib. Desm. Tapakoomas, 1895, p. 30, t. 2, f. 2, 3; West & G. S. West, Alg. S. England, 1897, p. 497; Obs. Conj. 1898, pp. 52, 54, t. 4, f. 22–33; Desm. U. S. 1898, p. 321; G. S. West, Brit. Freshw. Alg. 1904, p. 176, f. 68, E–H; West & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, t. 5, no. 6, f. 1.

Cells of medium size, $2\frac{1}{2}$–3 times longer than broad, subcylindrical, with an almost imperceptible median constriction, and a slight inflation on either side of it; apices broad and truncate; cells in vertical view circular, cells closely united to form short filaments, often enclosed in a broad gelatinous sheath. Cell-wall minutely punctulate, punctæ arranged in transverse rows. Chloroplasts axile, one in each semicell, typically with a single central pyrenoid in each, and plate-like, so that when viewed from the edge it seems very narrow, just as in *Mougiotia*.

Zygospores formed after the filaments have dissociated into individual cells, rounded, walls smooth, but sometimes with two rounded mamillæ at opposite poles.

Length 28–42 μ; breadth 11·5–14 μ; diam. zygosp. 23–28 μ.

England.—Plankton of Easedale Tarn, Westmoreland! Thursley Common, Surrey! New Forest, Hants (with zygospores)!

Wales.—Capel Curig, Carnarvonshire! In the plankton!

Scotland.—Rhiconich, and in the plankton of Lochs Shin and Ruar, Sutherland! Loch Shiel, Inverness! Plankton of Lochs Fadaghoda, an Sgath and Stranabhat, Lewis, Lochs Diracleet and Laxadale, Harris, and Loch nan Eun, N. Uist, Outer Hebrides!

Ireland.—Plankton of Galway!

Geogr. Distribution.—Norway. Ceylon. United States. Guiana.

This is one of the rarest of Desmids, and might easily be overlooked owing to its great similarity to other filamentous Conju-

gatæ. It is also more frequently found in plankton than in collections from bogs. Its chloroplasts are rather unusual for the genus *Hyalotheca*, although chloroplasts of this type occur, amongst other Desmidiaceæ, in the genus *Mesotænium*.

In addition to zygospores, the formation of aplanospores has been observed in this species. The filaments partially dissociate into individual cells during their formation. The cell-contents round themselves off, and finally acquire a thick cell-wall, which is yellowish and distinctly punctate when mature. The aplanospores are elliptical with acutely-rounded poles. Thus they are very different in appearance from the zygospores.

5. **Hyalotheca undulata** Nordst.

(Pl. CLXII, figs. 6–9.)

Hyalotheca undulata Nordst. in Wittr. & Nordst. Alg. exsic. 1879, no. 248, and in fasc. 21, 1889, p. 33; Wolle, Desm. U. S. 1884, p. 23, t. 53, f. 8; De Toni, Syll. Alg. 1889, p. 788: West, Freshw. Alg. N. Wales, 1890, p. 7 (sep.); Alg. W. Ireland, 1892, p. 117; Roy & Biss. Scott. Desm. 1893, p. 9, t. 1, f. 1; West & G. S. West, Some N. Amer. Desm. 1896, p. 232; Freshw. Chloroph. Koh Chang, 1901, p. 96; Alg. Ceylon, 1902, p. 195, t. 22, f. 27; Alg. Burma, 1907, p. 226.

H. undulata var. *producta* Turner, Freshw. Alg. E. India, 1893, p. 152, t. 18, f. 15.

Cells very small, $1\frac{1}{2}$–2 times longer than broad, lateral margins with a broad shallow median indentation, so that they are biundulate; semicells globose-obovate, with truncate apices; diameter of isthmus and apex of semicells about equal; cells in end view circular; chloroplasts axile, one in each semicell, each with a central pyrenoid and about 4 radiating ridges. The filaments may or may not be enclosed in a gelatinous sheath.

Zygospore unknown.

Length 10–17·5 μ; breadth 6–9 μ; diam. isthmus = diam. apices = 4·6–7·5 μ.

Wales.—Capel Curig, Carnarvonshire! In the plankton!

Scotland.—Birsemore Loch, Aberdeen (*Roy & Biss.*).

Ireland.—Lough Anna, Donegal! Roundstone, Ballynahinch, and in the plankton, Galway! Upper Lake of Killarney and Lough Guitane, Kerry! Adrigole, Cork!

Geogr. Distribution.—Sweden. Finland. India. Ceylon. Siam. United States.

This is one of the rarest of British Desmids. Its regularly undulate margins distinguish it from all other species of the genus.

Genus 25. **DESMIDIUM** Ag.

Agardh, Syst. Alg. 1824, p. xv.
Greville, Scott. Crypt. fl. 1828, vol. 6, p. 38; in Hook, Brit. Fl. 1833, p. 402.
Kütz. Synops. Diat. 1834, p. 85 (sep.).
Bréb. Alg. Falaise, 1835, p. 53 (sep.).
Menegh. Synops. Desm. 1840, p. 2 (sep.).
Ralfs in Ann. Mag. Nat. Hist. v. 9, 1842, p. 155 and 253.
Kütz. Phyc. generalis, 1843, p. 165.
Hassall, Brit. Freshw. Alg. 1845, p. 341.
Kütz. Phyc. germ. 1845, p. 141.
Ralfs, Brit. Desm. 1848, p. 60.
Kütz. Spec. Alg. 1849, p. 190.
Näg. Gatt. einz. Alg. 1849, p. 130.
De Bary, Conj. 1858, p. 76.
Wallich, Desm. low. Bengal, 1860, p. 186.
Arch. in Pritch. Inf. 1861, p. 723.
Rabenh. Krypt.-fl. Sachs. 1863, p. 180; Flor. Europ. Alg. 1868, p. 153.
Delp. Spec. Desm. subalp. 1873, p. 56.
Nordst. Norges Desm. 1873, p. 49.
Wood, Freshw. Alg. N. Amer. 1873, p. 126.
Kirchn. Alg. Schles. 1878, p. 132.
Gay, Monogr. loc. Conj. 1884, p. 44.
Wolle, Desm. U. S. 1884, p. 25.
Cooke, Brit. Desm. 1887, p. 9.
Hansg. Prodr. Alg. Böhm. 1888, p. 171.
De Toni, Syll. Alg. 1889, p. 779.
Wille in Engler, Naturl. Pflanzenf. 1890, p. 14.
Turn. Freshw. Alg. E. India, 1893, p. 149.
Comère, Desm. de France, 1901, p. 200.
G. S. West, Brit. Freshw. Alg. 1904, p. 177.
Didymoprium Kütz. Phyc. generalis, 1843, p. 165; Phyc. germ. 1845, p. 141; Ralfs, Brit. Desm. 1848, p. 55 (in part); Kütz. Spec. Alg. 1849, p. 189; Arch. in Pritch. Inf. 1861, p. 723 (in part); Rabenh. Krypt.-fl. Sachs. 1863, p. 180; Flor. Eur. Alg. 1868, p. 153; Delp. Spec. Desm. subalp. 1873, p. 52; Wille in Engler, Naturl. Pflanzenf. 1890, p. 15; Turn. Freshw. Alg. E. India, 1893, p. 150; [= Subgenus *Didymoprium* Nordst. Norges Desm. 1873, p. 49; Gay, Monogr. loc. Conj. 1884, p. 44; Hansg. Prodr. Alg. Böhm. 1888, p. 172; De Toni, Syll. Alg. 1889, p. 783].
Aptogonum Ehr. Inf. 1838, p. 382; Ralfs, Brit. Desm. 1848, p. 63; Wallich, Desm. low. Bengal, 1860, p. 191; Arch. in Pritch. Inf. 1861, p. 723; Rabenh. Flor. Eur. Alg. 1868, p. 155; Delp. Spec. Desm. subalp. 1873, p. 61; [= Subgenus *Aptogonum* Nordst. Norges Desm. 1873, p. 50; Hansg. Prodr. Alg. Böhm. 1888, p. 171; De Toni, Syll. Alg. 1889, p. 781].

Cells united to form twisting filamentous colonies, sometimes embedded in a thick mucous sheath; cells

often extremely depressed, usually much broader than long, with a distinct but only moderately deep constriction; in vertical view either elliptical, usually with mamillate poles, or 3- or 4-angled; chloroplasts axile, one in each semicell, with a massive lobe, containing a pyrenoid, radiating from the centre into each angle, or sometimes opposite to each face, and with a pair of plates extending into each angle; in forms with an elliptical vertical view the number of pyrenoids is more variable. The cells are attached to each other in forms with an elliptical vertical view merely by the close apposition of ridge-like thickenings on adjacent apices, and in the angular forms by short truncate processes projecting from the apices of the cell, one in each angle. In the latter case there is often a space of varying size between the apices of adjacent cells.

Zygospores rounded or ellipsoidal, smooth or sometimes with short flattened conical papillæ.

The genus *Desmidium*, together with the closely allied following genus *Gymnozyga* and the tropical genus *Streptonema*, differ from all other Desmids in their method of cell-division. In these genera, when a cell is dividing, that part of the cell-wall where the new and old walls abut on each other develops a ring-like thickening, which is transformed by further growth into a sort of invagination of the wall projecting into the old semicell. As the new semicell develops this plication straightens itself out. Where the cells are united by their whole apical surface only one such invagination is formed during cell-division. But where the union is effected by means of short apical processes as many invaginations are formed as there will eventually be processes. The projecting ridges of the new cell-wall are very conspicuous during cell-division.

There are eight British species of the genus, of which none is really abundant. These may be arranged as follows:

* Semicells with well-developed apical feet and cavities, easily seen, between adjacent cells.

1. *D. Aptogonum*.
2. *D. pseudostreptonema*.

** Cavities between cells absent, or not readily visible.
† Semicells angular in vertical view.
3. *D. occidentale.*
4. *D. Swartzii.*
†† Semicells circular or elliptical in vertical view, often with opposite mamillæ.
5. *D. cylindricum.*
6. *D. coarctatum.*
7. *D. graciceps.*
8. *D. quadratum.*

1. **Desmidium Aptogonum** Bréb.

(Pl. CLXIV, figs. 1–3.)

Desmidium Aptogonum Bréb. Alg. Falaise, 1835, p. 65, t. 2; Menegh. Synops. Desm. 1840, p. 3 (sep.); Kütz. Phyc. Germ. 1845, p. 141; Spec. Alg. 1849, p. 190; De Bary. Conj. 1858, p. 76, t. 6, f. 55, 56; Arch. in Pritch. Inf. 1861, p. 723, t. 3, f. 7, 8; Rabenh. Krypt.-fl. Sachs. 1863, p. 181; Reinsch, Alg. Frank. 1867, p. 206; Rabenh. Flor. Eur. Alg. 1868, p. 154; Kirchn. Alg. Schles. 1878, p. 132; Wolle, Desm. U. S. 1884, p. 27, t. 2, f. 6, 7, t. 49, f. 7; Cooke, Brit. Desm. 1887, p. 11, t. 5, f. 1; Hansg. Prodr. Alg. Böhm. 1888, p. 172; Hauptfl. Zellm. u. Hüllgall. Desm. 1888, pp. 20, 51, t. 2, f. 6, 10–15; De Toni, Syll. Alg. 1889, p. 781; West, Alg. N. Wales, 1890, p. 7; Alg. W. Ireland, 1892, p. 117; Turn. Freshw. Alg. E. India, 1893, p. 147; Roy & Biss. Scott. Desm. 1893, p. 9; West & G. S. West, Some N. Amer. Desm. 1896, p. 233, t. 12, f. 24; Desm. U. States, 1898, p. 320; Comère, Desm. de France, 1901, p. 201, t. 16, f. 10; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. Ceylon, 1902, p. 193; Alg. Burma. 1907, p. 226; Georgev. Desm. Macedon. 1910, p. 237; Borge, Sao Paulo Alg. 1918, p. 75.
Aptogonum Desmidium Ralfs, Brit. Desm. 1848, p. 64, t. 32, f. 1 *a–d*; Bréb. Liste Desm. 1856, p. 119; Delp. Spec. Desm. subalp. 1873, p. 61, t. 3, f. 1–5; Hustedt, Desm. et Bac. Tirol, 1911, p. 341.
Desmidium Swartzii Wallich, Desm. low. Bengal, 1860, p. 189, t. 7, f. 1, 4.
Desmidium Swartzii var. *amblyodon* West & G. S. West, Alg. Madagascar, 1895, p. 43, t. 9, f. 34, 35.

Cells of medium size, about twice as broad as long, constriction not deep, but open and acute; semicells narrowly oblong, lateral angles broadly rounded, apex broad and concave in the middle, but produced at the angles to form fairly long connecting processes, so that a cavity of considerable size is left between the adjacent cells; in end view usually triangular, sometimes quadrangular, angles very broadly rounded, sides concave; chloroplasts axile, one in each semicell, with a massive lobe radiating from the centre into each angle, and a pyrenoid embedded in each mass. Filaments

often long and twisted, usually destitute of a gelatinous sheath.

Zygospores large, smooth and subspherical, produced after the partial or total dissociation of the filaments into individual cells.

Length 13–18 μ; breadth 26–30 μ; breadth of isthmus 21–24 μ; breadth of apices 21–24 μ; diam. zygosp. 18–26 μ.

ENGLAND.—Ambleside (*Ralfs*), Loughrigg!, Scandale!, Bowness! (*Bissett*) and in the plankton of Windermere!, Westmoreland. Strensall (*W. B. Turn.*), and Pilmoor!, N. Yorks.

WALES.—Capel Curig! (*Cooke & Wills*), Llyn Padarn!, Llyn Idwal!, and in the plankton!, Carnarvonshire. Llyn Coron, Anglesey! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Not common; Sutherland!, Aberdeen, Kincardine, Forfar, Perth, Argyle and Fife (*Roy & Biss.*). Plankton of Loch Ruar, Sutherland!, Lochs Cuthaig and Fadaghoda, Lewis!, Loch Laxadale, Harris!, and Loch Nan Eun, N. Uist, Outer Hebrides!

IRELAND.—Ballynahinch, and Roundstone, Galway!

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Turkey. Italy. Norway. Sweden. Denmark. Finland. Japan. India. Ceylon. Burma. Java. Australia. Madagascar. Sandwich Isles. United States. Brazil. Ecuador. Colombia.

D. Aptogonum is readily distinguished from all other British species by the large and distinct spaces between adjacent cells. It is not at all common, but occurs in plenty in the bogs near Capel Curig Lake, Carnarvonshire.

Var. **Ehrenbergii** Kütz. (Pl. CLXIV, figs. 4, 5.)

Odontella Desmidium Ehr. Inf. 1838, p. 153, t. 16, f. iv.
Aptogonum Desmidium var. β Ralfs, Brit. Desm. 1848, p. 64, t. 32, f. 1, *e–h*.
Desmidium Aptogonum var. *Ehrenbergii* Kütz. Spec. Alg. 1849, p. 190; Rabenh. Flor. Europ. Alg. 1868, p. 154; Hansgirg, Prod. Alg. Böhm. 1888, p. 172; De Toni, Syll. Alg. 1889, p. 781; West & G. S. West, Some N. Amer. Desm. 1896, p. 233, t. 12, f. 23; Alga-fl. Yorks. 1902, p. 110.
Aptogonum diagonum Delp. Spec. Desm. subalp. 1873, p. 64, t. 3, f. 6–10.

Filaments flattened and not twisted, cells in vertical view oblong with rounded poles, and sides slightly concave.

Length 14–19 μ; breadth 25–32·5 μ; breadth of isthmus 22–24 μ; breadth of apices 19–28 μ.

ENGLAND.—Strensall Common, N. Yorks!

SCOTLAND.—Rare. Pools near Birsemoor Loch, Aberdeen; near Banchory, Kincardine (*Roy & Biss.*).

Geogr. Distribution. — France. Germany. Italy. Sweden. Denmark. United States.

Var. **acutius** Nordst. (Pl. CLXIV, fig. 6.)

Desmidium Aptogonum var. *acutius* Nordst. Alg. Sandvic. 1878, p. 11, t. 1, f. 21, 22; De Toni, Syll. Alg. 1889, p. 782; West, Alg. Engl. Lake Distr. 1892, p. 7; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Hirn, Desm. Finnland, 1903, p. 14.

Lateral angles in the front view not broadly rounded, but slightly retuse in the upper part, so that a subacute angle points towards the apex of the semicell; in other respects similar to the type; triangular or quadrangular in the vertical view.

Length 16–23 μ; breadth 32–43 μ; breadth of isthmus 26–34 μ; breadth of apices 26–34 μ.

ENGLAND.—Bowness, Westmoreland! Pilmoor, N. Yorks!

Geogr. Distribution.—Galicia in Austria. Finland. Java. Australia. Sandwich Isles. United States.

2. **Desmidium pseudostreptonema** W. & G. S. West. (Pl. CLXV, figs. 5, 6.)

Desmidium pseudostreptonema West & G. S. West, Alg. Ceylon, 1902, p. 193, t. 22, f. 35–37; Compar. Study Plankton Irish Lakes, 1906, p. 104, t. 11, f. 23.

Cells of medium size, somewhat compressed, 1½–2 times broader than long, deeply constricted, sinus narrow, gradually inflated very slightly towards the apex; semicells transversely and narrowly oblong, sides rounded, apex rather convex, with short connect-

ing processes; in vertical view triangular or bilobed, with a slight constriction beneath each angle, angles rounded, slightly produced, sides straight, or slightly convex.

Zygospore unknown.

Length 17–21 μ; breadth 31–35 μ; breadth of isthmus 13·5–22 μ; breadth of apices 14–15·5 μ.

Ireland.—Plankton of small lake between Clifden and Roundstone, Galway.

Geogr. Distribution. — Finland. Norway. Ceylon. Australia.

This plant presents a great similarity in appearance to *Spondylosium pulchrum* Arch., especially the bilobed form. The short connecting processes on the apices of the semicells are, however, sufficient to distinguish it readily from that species. Moreover, the lateral lobes of the semicells are different from those of any form of *Sp. pulchrum*.

It has also a considerable resemblance to *Streptonema trilobatum* Wallich, but differs entirely in the nature of the connections between the cells, which are those of a true *Desmidium*. A gap of some considerable size is generally evident between the apices of any two contiguous cells. The filaments are usually enveloped in a thick mucous sheath.

3. **Desmidium occidentale** W. & G. S. West.

(Pl. CLXIV, fig. 11.)

Desmidium occidentale West & G. S. West, Further Contrib. Plankt. Scott. Lochs, 1905, p. 505, t. 6, f. 3, 4; Borge, Sao Paulo Alg. 1918, p. 75, t. 6, f. 12.

Cells of medium size, $1\frac{1}{4}$ times broader than long, slightly constricted, sinus narrow, sublinear; semicells oblong semielliptical, lateral margins gently biundulate, angles rounded, apex truncate-convex, with extremely short connecting processes; cavities between the cells small or wanting; in vertical view triangular, sides nearly straight or slightly convex, angles slightly produced and rounded. Chloroplasts axile, one in each

semicell, with a central pyrenoid. Filaments twisted, with or without a mucous sheath.

Zygospore unknown.

Length 25·5–28 μ; breadth 32·5–38·5 μ: breadth of isthmus 23–28·5 μ; breadth of apices 21–25·5 μ.

Scotland.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Geogr. Distribution.—Brazil.

This species, although occurring abundantly in the plankton of Loch Fadaghoda, has not been observed from any other locality in Britain. It is distinguished from *D. Swartzii* by the proportionately greater length of its cells, and by the shortened and more rounded lateral angles of the semicells. The vertical view is likewise more robust, and the sides are convex (not concave as in *D. Swartzii*). There is usually no trace of a space between the apices of adjacent cells, but it may sometimes be detected with high magnification.

4. **Desmidium Swartzii** Ag.

(Pl. CLXIII, figs. 5–8.)

Diatoma Swartzii Agardh, Disp. Alg. 1812, p. 38.

Desmidium Swartzii Agardh, Syst. Alg. 1824, p. 9; Grev. Scott. Crypt. Fl. 1827, v. 5, t. 292, v. 6, p. 32; in Hook. Brit. Fl. 1833, p. 402; Kütz. Synops. Diat. 1834, p. 85 (sep.); Bréb. Alg. Falaise, 1835, pp. 53, 267, t. 2, 5; Menegh. Synops. Desm. 1840, p. 203; Ralfs in Ann. Mag. Nat. Hist. v. 11, 1843, p. 375, t. 8, f. 3; ibid. v. 15, 1845, p. 405; Hass. Brit. Freshw. Alg. 1845, p. 344, t. 83, f. 7, 8; Kütz. Phyc. Germ. 1845, p. 141; Ralfs, Brit. Desm. 1848, p. 61, t. 4; Kütz. Spec. Alg. 1849, p. 190; Näg. Gatt. einz. Alg. 1849, p. 131, t. 8 D; Bréb. Liste Desm. 1856, p. 119; De Bary, Conj. 1858, p. 76, t. 6, f. 57; Arch. in Pritch. Inf. 1861, p. 723; Rabenh. Krypt.-fl. Sachs. 1863, p. 180; Reinsch, Alg. Frank. 1867, p. 205; Rabenh. Flor. Europ. Alg. 1868, p. 154; Delp. Spec. Desm. subalp. 1873, p. 56, t. 2, f. 8–20; Kirchn. Alg. Schles. 1878, p. 132; Gay, Monogr. loc. Conj. 1884, p. 80, t. 3, f. 3; Wolle, Desm. U. S. 1884, p. 26, t. 2, f. 1–5; Cooke, Brit. Desm. 1887, p. 10, t. 5, f. 2; Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, p. 191, t. 2, f. 1–5, 7–9; Hansg. Prodr. Alg. Böhm. 1888, p. 171; Nordst. Freshw. Alg. N. Zealand, 1888, p. 25; De Toni, Syll. Alg. 1889, p. 780; West, Alg. N. Wales, 1890, p. 7 (sep.); Alg. W. Ireland, 1892, p. 117; Alg. Engl. Lake Distr. 1892, p. 7; Roy & Biss. Scott. Desm. 1893, p. 9 (sep.); West & G. S. West, Alg. S. England, 1897, p. 497; Comère, Desm. de France, 1901, p. 200, t. 16, f. 11; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. N. Ireland, 1902, p. 59; G. S. West, Brit. Freshw. Alg. 1904, p. 178, f. 69 A; West & G. S. West, Alg. Burma, 1907, p. 226; Georgev. Desm. Wlasina See, 1909, p. 190; Desm. Macedonia, 1910, p. 237; Hustedt, Desm. et Bacill. Tirol, 1911, p. 342; Kaiser, Alg. Traunst. u. Chiem. 1914, p. 154.

Filaments triangular, twisted, usually destitute of a conspicuous gelatinous sheath; cells large, about $2\frac{1}{2}$ times broader than long, constriction moderately deep, sinus linear towards its apex, opening more widely; semicells narrowly oblong, lateral margins usually somewhat obliquely truncate, with the upper angle of the truncate margin conspicuously protruded towards the apex of the semicell, the lower angle more rounded; apex of semicell broadly truncate, with a short connecting process at each angle of the cell; middle of apex very slightly concave; spaces between the cells not visible, or recognised only with difficulty; vertical view triangular, angles acutely rounded, sides slightly concave; chloroplasts axile, one in each semicell, with two massive lobes radiating from the centre into each angle of the semicell, and a large pyrenoid opposite each face.

? Zygospores smooth and oval.

Length 12–20 μ; breadth 37–50 μ; breadth of isthmus 30–42·5 μ; breadth of apices 30–41 μ; length of zygospore 28–36 μ; breadth 20–28 μ.

England.—Cumberland! Westmoreland, at 2400 ft. on Helvellyn, and in the plankton of Grasmere! Lancashire! (*Ralfs*). W. and N. Yorks! Essex (*Hassall*). Warwicks! (*Wills*). Berks (*Griffiths*). Surrey! Sussex (*Ralfs*). Hants! (*Bennett*). Dartmoor, Devon (*Harris*) Cornwall!

Wales.—Capel Curig!, Llyn Idwal!, and in the plankton!, Carnarvonshire. Llyn Coron, Anglesea! Dolgelly, Merioneth (*Ralfs*). Swansea, Glamorgan (*Ralfs*).

Scotland. — General; zygospores at Tomacher, Aberdeen (*Roy & Biss.*). In the plankton! Bute! Harris, Outer Hebrides!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Arch.*). Meath (*Ralfs*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Hungary. Servia. Roumania. Turkey. Italy. Spain. Portugal. Norway.

Sweden. Denmark. Finland. Poland. Central, N., and S. Russia. Greenland. Japan. India. Burma. Australia. New Zealand. Central Africa. Nova Scotia. United States. Colombia. Brazil. Paraguay.

D. Swartzii is the commonest species of *Desmidium*. It has a very extensive distribution, and sometimes occurs in abundance.

There has been some confusion with regard to the zygospores of this species. Ralfs, in 1848, figured certain spores which he supposed had been formed each from the contents of a single cell. Various other authors have published from time to time figures quite similar to that of Ralfs, under the description of zygospores. Archer in 'Quart. Journ. Micr. Sci.' v. 7, 1867, p. 296, reports that he had observed conjugation in this species, and that Ralfs' figure was quite accurate, but that the earlier observer was wrong in supposing that the spores were formed each from a single cell. Archer states that the conjugating filaments apply themselves so closely to each other that it is very difficult to distinguish that there really are two there. Archer had quite satisfied himself, however, that this was so. Crowe, in 'Quart. Journ. Micr. Sci.' 1874, p. 105, again supported Archer's statement. Further, Delponte ('Spec. Desm. Subalp.' 1873, t. 2, f. 12) figures spores which he says are formed by the conjugation of two cells, and these are quite similar to those of Ralfs. In view of this evidence, together with the fact that if Ralfs' figure represents one filament, and not two, it is of extraordinary large diameter, it seems highly probable that the figures of Ralfs, and similar ones of other authors, may be considered to represent the zygospores of this species, with varying degrees of accuracy, but further corroboration of this is certainly desirable.

Var. **quadrangulatum** (Ralfs) Roy. (Pl. CLXIII, figs. 9, 10.)

D. quadrangulatum Ralfs in Ann. Mag. Nat. Hist. 1845, p. 405, t. 12, f. 9; Brit. Desm. 1848, p. 62, t. 5; Arch. in Pritch. Infus. 1861, p. 723, t. 2, f. 37; Rabenh. Flor. Eur. Alg. 1868, p. 155; Delp. Spec. Desm. subalp. 1873, p. 60, t. 2, f. 21–27; Wolle, Desm. U. S. 1884, p. 27, t. 2, f. 13, 14; Cooke, Brit. Desm. 1887, p. 11, t. 5, f. 3; Comère, Desm. de France, 1901, p. 200, t. 16, f. 13; Borge, Alg. erst. Regnel. Exp 1903, p. 122, t. 5, f. 24; Hustedt, Desm. et Bacill. Tirol, 1911, p. 342; Borge, Sao Paulo Alg. 1918, p. 75.

D. quadrangulare Kütz. Phyc. germ. 1845, p. 141; De Toni, Syll. Alg. 1889, p. 780.
D. Swartzii var. *quadrangulatum* Roy & Biss. Scott. Desm. 1894, p. 9; West & G. S. West, Alg. N. Ireland, 1902, p. 59.

Differs from the typical form only in its quadrangular vertical view, and consequent greater relative breadth in the front view.

Zygospore elliptical; inner layer of membrane tawny.

Length 24·8 μ; breadth 57·6–60 μ; length of zygospore 47 μ; breadth 32·5 μ.

England.—Ambleside (*Ralfs*) and Loughrigg (*Bennett*), Westmoreland. Penzance and Tremethick Moor, Cornwall (*Ralfs; Marquand*).

Scotland.—Scotston Moss, Heughhead near Aboyne, and Blackmoss in Cromar, Aberdeen (*Ralfs; Roy & Biss.*). Braemar, Aberdeen!

Ireland.—Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Italy. Poland. Australia. E. Africa. Madagascar. United States. Colombia. Brazil. Paraguay.

Var. **amblyodon** (Itz.) Rabenh. (Pl. CLXV, fig. 7.)

Desmidium amblyodon Itz. in Rabenh. Bacill. Sachs. fasc. 7, 1852, no. 65, t. v, f. 65.
D. Swartzii var. *amblyodon* Rabenh. Krypt.-fl. Sachs. 1863, p. 181; Flor. Europ. Alg. 1868, p. 154; De Toni, Syll. Alg. 1889, p. 780; West, Freshw. Alg. Maine, 1891, p. 354; Borge, Sao Paulo Alg. 1918, p. 75.

Cells with lateral angles not obliquely truncate, but distinctly and broadly rounded. Filaments often enclosed in a mucous sheath.

Length 15–20 μ; breadth 32–50 μ; breadth of isthmus 25–45 μ.

Ireland.—Near Ballynahinch, Galway!

Geogr. Distribution.—Germany. Sweden. United States. Brazil.

5. **Desmidium cylindricum** Grev.

(Pl. CLXIV, figs. 7–10.)

Desmidium cylindricum Grev. Scott. Crypt. Fl. 1827, vol. v, t. 293, vol. vi, p. 38; in Hook. Brit. Flor. 1833, p. 402; Kütz. Synops. Diat. 1834, p. 86; Menegh. Synops. Desm. 1840, p. 4 (sep.); Ralfs in Ann. Mag.

Nat. Hist. v. 11, 1843, p. 373, t. 8, f. 1; Hass. Brit. Freshw. Alg. 1845, p. 342, t. 83, f. 1, 2; Kirchn. Alg. Schles. 1878, p. 132; Wolle, Desm. U. S. 1884, p. 25, t. 3, f. 1–4, t. 24, f. 25; Cooke, Brit. Desm. 1887, p. 9, t. 4, f. 2; Hansg. Prodr. Alg. Böhm. 1888, p. 172; De Toni, Syll. Alg. 1889, p. 783; West, Alg. W. Ireland, 1892, p. 117; Lütkem. Desm. Attersees, 1893, p. 538; West & G. S. West, Some N. Amer. Desm. 1896, p. 233, t. 12, f. 29; Obs. Conj. 1898, p. 52; Comère, Desm. France, 1901, p. 201, t. 16, f. 9; Lütkem. Zellmembr. Desm. 1902, p. 361, t. 19, f. 7; West & G. S. West, Alga-fl. Yorks. 1902, p. 110; Alg. N. Ireland, 1902, p. 60; Alg. Ceylon, 1902, p. 194; G. S. West, Brit. Freshw. Alg. 1904, p. 177, f. 69 C; Borge, Sao Paulo Alg. 1918, p. 74.

Arthrodesmus ? cylindricum Ehr. Inf. 1838, p. 142.

Hyalotheca cylindricum Ehr. in Berlin Monatsb. 1840, p. 212.

Desmidium compressum Corda in Alm. de Carlsbad, 1840, p. 18.

Didymoprium Grevillii Kütz. Phyc. generalis, 1843, p. 166; Phyc. Germ. 1845, p. 141; Ralfs, Brit. Desm. 1848, p. 57, t. 2; Kütz. Spec. Alg. 1849, p. 189; Bréb. Liste Desm. 1856, p. 118; Arch. in Pritch. Inf. 1861, p. 723; Rabenh. Krypt.-fl. Sachs. 1863, p. 180; Reinsch, Alg. Frank. 1867, p. 207; De Not. Desm. Ital. 1867, p. 27, t. 1, f. 3; Rabenh. Flor. Europ. Alg. 1868, p. 153; Delp. Spec. Desm. subalp. 1873, p. 52, t. 1, f. 20–28; Hauptfl. Zellm. u. Hullgallerte Desm. 1888, p. 16 and 50, t. 1, f. 39–60 (sep.); Hustedt, Desm. et Bacill. Tirol, 1911, p. 342; Kaiser, Alg. Traunst. u. Chiemgau, 1914, p. 154.

D. cylindricum Ralfs in Ann. Mag. Nat. Hist. v. 16, 1845, p. 10, t. 3, f. 4; Turn. Alg. E. India, 1893, p. 150.

Desmidium Grevillii De Bary, Conj. 1858, p. 76, t. 4, f. 30–31.

D. (*Didymoprium*) *cylindricum* Nordst. Norges Desm. 1873, p. 49.

Cells large, about 2–2½ times broader than long, constriction slight, sinus linear; semicells very short, pyramidate-truncate, basal angles acutely rounded, lateral margins gently biundulate; apex broad and truncate: cells in vertical view elliptical with a rounded mamilla-like protuberance at each pole; chloroplasts axile, one in each semicell, usually with four massive radiating lobes, in each of which is a pyrenoid; cells united by their broad, flat apices to form twisting filaments, with a thickened protruding rim between each pair of cells; filaments usually enclosed in a gelatinous sheath.

Zygospores formed after the dissociation of the filament into individual cells; large and smooth, globose or subglobose, contained in one of the conjugating cells, the other remaining attached.

Length about 24 μ; greatest breadth 41–56 μ; breadth of isthmus 45–47 μ; breadth of apices 26–40 μ; thickness 25–38 μ; diam. zygosp. 26–40 μ. [Much larger specimens sometimes occur, but exact measurements of such individuals were not available.]

England.—Loughrigg, Westmoreland! Adel Bog, W. Yorks, and Strensall, N. Yorks (*W. B. Turn.*). Warwicks! Thursley Common, Surrey! New Forest, Hants! Dartmoor, Devon (*Harris*). Cornwall! (*Marquand*).

Wales.—Capel Curig (*Cooke & Wills*) and Bettws-y-coed (*Roy*), Carnarvonshire.

Scotland.—General; zygospores from Slewdrum in Birse (*Roy & Biss.*).

Ireland. — Donegal (zygospores from Dungloe)! Achill Isle, Mayo! Galway (zygospores from Ballynahinch)! Kerry! Dublin and Wicklow (*Arch.*).

Geogr. Distribution.—France. Germany. Switzerland. Galicia and Austria. Italy. Norway. Sweden. Denmark. Finland. Poland. N. and S. Russia. India. Ceylon. Australia. United States. Guiana. Colombia. Brazil. Paraguay.

D. cylindricum, although one of the most frequent of all the species of the genus, and at the same time fairly widely distributed, is rarely abundant. It is one of the largest species, and is easily recognised by its short broad cells with their simple apical attachment, and the elliptical vertical view, with a small mamilla at opposite poles. Raciborski has seen a triradiate form of the species, in which the end view has three equidistant mamillæ on the nearly circular outline.

The most peculiar and important fact about *D. cylindricum* is that its zygospore is formed within one of the conjugating cells. This is the only known Desmid in which the reproduction is normally of such a high type that the conjugating cells can be distinguished definitely as ♂ and ♀ gametangia, although the same thing is known to occur occasionally as an abnormality in *Hyalotheca dissiliens*. It is supposed that in this phenomenon the method of reproduction of the immediate ancestors is disclosed, *i. e.* the ancestors of the Desmidieæ were filamentatous, and had a well differentiated type of sexual reproduction. In the evolution of the Desmidieæ the acquisition of the unicellular condition and the development of a highly complicated morphological structure has gone hand in hand with the degeneration of the form of reproduction, so that the former high type only remains in the above-mentioned cases.

6. **Desmidium coarctatum** Nordst.

(Pl. CLXV, figs. 1, 2.)

Desmidium (Didymoprium) coarctatum Nordst. Botan. Notiser, 1887, p. 155. *D. coarctatum* Nordst. Freshw. Alg. N. Zealand, 1888, p. 25, t. 2, f. 3; De Toni, Syll. Alg. 1889, p. 785; Borge, Austral. Süsswasserchl. 1896, p. 8; W. & G. S. West, Some N. Amer. Desm. 1896, p. 233; Nordst. Index Desm. 1896, p. 76; W. & G. S. West, Desm. U. States, 1898, p. 321, f. 7; Freshw. Alg. Ceylon, 1902, p. 194; Playfair, New S. Wales Census, 1917, p. 240.

Filaments flattened, twisted, cells in front view elliptical, about $1\frac{1}{2}$ times broader than long, with a slight median constriction, sinus linear, basal angles of semicell acutely rounded, lateral margins slightly undulate; apex of semicell about $\frac{1}{3}$ its diameter; lateral view of cell quadrangular, with the faintest indication of a median constriction; vertical view narrowly elliptical with prominent rounded mamillæ at the opposite poles. Cell-wall with longitudinal rows of minute punctæ; chloroplasts axile, one in each semicell, each with a central pyrenoid.

Zygospore unknown.

Length 25–34 μ; breadth 34–38 μ; breadth of isthmus 33 μ; breadth of apex 12–14 μ; thickness 24–26 μ.

Geogr. Distribution.—Finland. Ceylon. Australia. New Zealand. United States.

Var. **cambricum**. (Pl. CLXV, figs. 3, 4.)

D. coarctatum var. *cambricum* West, Alg. N. Wales, 1890, p. 7, f. 2; W. & G. S. West, Further Contr. Plankt. Scott. Lochs, 1905, p. 505, t. 4, no. 5, f. 1.

Differs from the type in its different proportions and in the broader apices of the cells.

Length 22·5 μ; breadth 40–45 μ; breadth of isthmus 35–37·5 μ; breadth of apex 17·5–20 μ; thickness 32–35 μ.

Wales.—Capel Curig, Carnarvonshire! In the plankton!

Scotland.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

The type form of this species has not yet been recorded for this country, and var. *cambricum* is extremely rare. Both the typical form and the variety seem to be subject to considerable variation in the relative proportions of their cells, and the two examples of var. *cambricum* figured present a considerable difference of habit; *cf.* Pl. CLXV, figs. 3, 4. The example figured from Loch Fadaghoda (fig. 4) seems to conform more nearly to the typical form in the proportions of its cells, but differs greatly in its chloroplasts. Typical *D. coarctatum* has only one pyrenoid in the centre of its axile chloroplast, which has about 12 ridges or radiating plates, whilst the specimens of var. *cambricum* from Loch Fadaghoda had a distinctly 4-lobed axile chloroplast, with a pyrenoid in each lobe. It is to be desired that these forms should be examined more thoroughly with regard to the chloroplasts.

7. **Desmidium graciceps** (Nordst.) Lagerh.

(Pl. CLXVI, fig. 5.)

Desmidium quadratum var. *graciceps* Nordst. in Wittr. & Nordst. Alg. exsic. no. 367, 1880.

D. graciceps Lagerh. Bidr. Amer. Desm.-fl. 1885, p. 228, t. 27, f. 3; Nordst. Alg. N. Zealand, 1888, p. 25; De Toni, Syll. Alg. 1889, p. 784; Börg. Desm. Brasil. 1890, p. 25; Turn. Alg. E. India, 1893, p. 150; W. & G. S. West, Alg. Ceylon, 1902, p. 194; Scott. Freshw. Plankt. I, 1903, p. 552; Borge, Sao Paulo Süsswasseralg. 1918, p. 74.

Cells in front view rotund, about as long as broad, constriction slight, sinus narrow; semicells shortly pyramidate-truncate, lateral margins biundulate, basal angles acutely rounded, apex truncate; side view of cell quadrate, rather longer than broad, lateral margins slightly concave. Chloroplasts axile, one in each semicell, with a central pyrenoid, and 6–8 radiating plates.

Zygospore subrectangular, provided with a number of short, stout nodules at the two opposite ends only, smooth in the middle part.

Length 18–24 μ; breadth 21–26 μ; breadth of isthmus 16–20 μ; breadth of apex 9–11 μ; thickness 16–18 μ; length of zygosp. 26–30 μ; breadth 22–24 μ; length of spines about 3–4 μ; breadth of spines about 2·5 μ.

SCOTLAND.—Plankton of Loch nan Eun, N. Uist, and Loch Fadaghoda, Lewis, Outer Hebrides!

Geogr. Distribution.—India. Ceylon. New Zealand. United States. Brazil.

8. **Desmidium quadratum** Nordst.

(Pl. CLXVI, figs. 6, 7.)

Desmidium (*Didymoprium*) *quadratum* Nordst. Norges Desm. 1873, p. 49, t. 1, f. 24.

D. quadratum Arch. in Journ. Bot. 1874, p. 92; Wolle, Desm. U. S. 1884, p. 26, t. 49, f. 5; Lagerh. Bidr. Amer. Desm.-fl. 1885, p. 227, t. 27, f. 1; De Toni, Syll. Alg. 1889, p. 784; Roy & Biss. Scott. Desm. 1893, p. 9; W. & G. S. West, Some N. Amer. Desm. 1896, p. 233, t. 12, f. 25; Desm. U. S. 1898, p. 321; Alg. Ceylon, 1902, p. 194 (forma); G. S. West, Brit. Freshw. Alg. 1904, p. 177, f. 69 B; Fritch, Alg. Ceylon, 1907, p. 245, f. 4 F; Bernard, Alg. unicell. domaine Malais, 1909, p. 19, t. 1, f. 12.

Didymoprium quadratum Racib. Nonn. Desm. Polon. 1885, p. 11.

Filaments nearly cylindrical, twisted; cells about $1\frac{1}{4}$ times broader than long, slightly constricted, with a shallow linear sinus, semicells short, pyramidate-truncate, lateral margins biundulate, basal angles acutely rounded; apex rather broad and truncate; side view of semicell quadrangular with scarcely any trace of a median constriction. Vertical view subcircular with 2 opposite mamillæ. Chloroplasts axile, one in each semicell with a central pyrenoid and 6 or 7 radiating plates.

Zygospore globose or subglobose, with a thick, smooth membrane.

Length 19–20 μ; breadth 25 μ; breadth of apex 12·5 μ; thickness 19–20 μ; diam. zygosp. 24–28 μ.

SCOTLAND.—Very rare: Slewdrum in Birse, Aberdeen (*Roy & Biss.*).

Geogr. Distribution.—Galicia in Austria. Norway. Sweden. Poland. Afghanistan. Ceylon. United States. Guiana. Brazil.

This species is very similar in form to the preceding one, except that it is relatively broader. The zygospores of the two species are, however, quite different.

Genus 26. **GYMNOZYGA** Ehren. 1841.

Ehrenb. in Berlin Monatsb. 1841, p. 212 (with description only of *G. moniliformis*).

Jacobs. Desm. Danem. 1875, p. 213.
Hansg. Prodr. Alg. Böhm. 1888, p. 169.
De Toni, Syll. Alg. 1889, p. 797.
Wille in Engler Natur. Pflanzenfam. 1890, p. 15.
G. S. West, Brit. Freshw. Alg. 1904, p. 178.
Bambusina Kütz. Phyc. germ. 1845, p. 140; Spec. Alg. 1849, p. 188.
De Bary, Conj. 1858, p. 76.
Rabenh. Flor. Eur. Alg. 1868, p. 152.
Delp. Desm. subalp. 1877, p. 54.
Kirchn. Alg. Schles. 1878, p. 132.
Wolle, Desm. U. S. 1884, p. 24.
Cooke, Brit. Desm. 1887, p. 8
Comère, Desm. France, 1901, p. 197.

Cells cylindrical or barrel-shaped, united by their flat ends to form slightly twisted filaments. There is a very slight median constriction, and often a swelling of variable size at the base of each semicell. Vertical view circular, often with two opposite mamillæ. Cell-division similar to that of *Desmidium*.

Zygospore smooth, oval or subglobose.

The genus *Gymnozyga* is very closely related to *Desmidium*, and it has been suggested by many previous authors that the two genera should be united. However, the distinctive characters of its form, the elongated barrel-shaped cells and the entire absence of a distinct median incision, both characters which contrast strongly with *Desmidium*, seem to justify the retention of *Gymnozyga*.

There is only one British species of the genus.

1. **Gymnozyga moniliformis** Ehrenb. (Pl. CLXV, figs. 8, 9.)

Gymnozyga moniliformis Ehrenb. in Berlin Monatsb. 1841, p. 212; Nordst. Bornh. Desm. 1888, p. 209; De Toni, Syll. Alg. 1889, p. 797; West, Alg. W. Ireland, 1892, p. 117; Alg. Engl. Lake Distr. 1892, p. 7; Turn. Freshw. Alg. E. India, 1893, p. 151; Roy & Biss. Scott. Desm. 1893, p. 10; West & G. S. West, Alg. S. England, 1897, p. 497; Alga-fl. Yorks. 1901, p. 111; Welw. Afric. Alg. 1897, p. 53; Alg. N. Ireland, 1902, p. 60; Alg. Burma, 1907, p. 226; Fritch. Alg. Ceylon, 1907, p. 237, f. 3, K; Bernard, Alg. unicell. domaine Malais, 1909, p. 23, t. 1, f. 19; Borge, Sao Paulo Süsswasseralg. 1918, p. 77.

Desmidium Borreri Ralfs in Ann. Mag. Nat. Hist. 1843. ii, p. 375, t. 8, f. 4; Hass. Brit. Freshw. Alg. 1845, p. 343, t. 83, f. 9, 10.

Bambusina Brebissonii Kütz. Phyc. germ. 1845, p. 140; Spec. Alg. 1849, p. 188; De Bary, Conj. 1858, p. 76, t. 4, f. 28, 29; Rabenh. Flor. Eur. Alg. 1868, p. 153; Kirchn. Alg. Schles. 1878, p. 132; Wolle, Desm. U.S. 1884, p. 24, t. 1, f. 15–21 (?); Cooke, Brit. Desm. 1887, p. 9, t. 4, f. 1; Hauptfl. Zellm. Hüllgallerte Desm. 1888, pp. 13, 56, t. 1, f. 19–21, 24, 25, 31–38.

Didymoprium Borreri Ralfs in Ann. Mag. Nat. Hist. xvi, 1845, p. 10, t. 3,

f. 5; Brit. Desm. 1848, p. 58. t. 3; Arch. in Pritch. Infus. 1861, p. 723, t. 2, f. 38, 39.
Bambusina Borreri Delp. Spec. Desm. subalp. 1877, p. 54, t. 2, f. 1–7.
Gymnozyga Brebissonii Wille in Engler. Natur. Pflanzenfam. 1890, p. 15, t. 9 J; Hustedt, Desm. Bac. Tirol, 1911, p. 342.

Filaments twisting, formed of rather barrel-shaped cells; semicells with a small basal inflation, and an extremely slight median constriction; lateral margins straight except for the broad rim at the base, apex broad and truncate; cell-wall often showing very delicate longitudinal striations; vertical view circular, sometimes with two opposite mamillæ. Chloroplasts axile, one in each semicell, each having a central pyrenoid and about 6 radiating plates.

Zygospores oval and smooth.

Length 25–30 μ; breadth 17·5–22·5 μ; length of zygospore 25–30 μ; breadth 16–20 μ.

England.—Cumberland! Westmoreland, and in the plankton of Codale and Easedale Tarns! Lancashire (*Ralfs*). W., N., and E. Yorks! Warwicks (*Wills*). Surrey! Sussex (*Ralfs*). Hants! Devon! (*Harris*). Cornwall!

Wales.—General! In the plankton!

Scotland.—General! zygospores from Aberdeen, Kincardine, Perth and Argyle (*Roy & Biss.*). Lewis and Harris, Outer Hebrides! Hoy, Orkneys! Not uncommon in the plankton!

Ireland.—General! Zygospores from near Recess, Galway! Mayo! Plankton of Galway and Kerry!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Bohemia. Hungary. Italy. Spain. Norway. Sweden. Denmark. Finland. N. Russia. Spitzbergen. Manchuria. India. Ceylon. Burma. Singapore. Java. Australia. New Zealand. E. Africa. Sandwich Isles. United States. Guiana. Brazil. Colombia.

Var. **gracilescens** Nordst. (Pl. CLXV, fig. 10; Pl. CLXVI, fig. 10.)

Bambusina Borreri var. *gracilescens* Nordst. in Wittr. & Nordst. Alg. Exs. fasc. 7, 1880, no. 367, fasc. 21, 1889, p. 34.

Bambusina Brebissonii var. *gracilescens* Wolle, Desm. U. S. 1884, p. 25.
Gymnozyga moniliformis var. *gracilescens* De Toni, Syll. Alg. 1889, p. 798; W. & G. S. West, Some N. Amer. Desm. 1896, p. 232, t. 12, f. 19; Alg. Ceylon, 1902, p. 194: Further Contrib. Plankt. Scott. Lochs, 1905, p. 506; Borge, Sao Paulo Alg. 1918, p. 77, t. 5, f. 38.

Differs from the typical form only in the smaller relative breadth of the cells.

Zygospores rectangular with rounded angles.

Length 24–30 μ; breadth 14–17 μ; length of zygospore 28–37 μ; breadth 18–23 μ.

SCOTLAND.—In the plankton!

Geogr. Distribution.—Sweden. Ceylon. Java. United States. Brazil.

ADDENDA.

(Including recently described species and changes in nomenclature.)

The late Dr. Lütkemüller, during the twenty years preceding his death, made some careful investigations of cell-wall structure in Desmids, and as a result of his work a number of species must now be placed in a different generic position from that originally assigned to them. Several genera are concerned in these changes, and the majority of the alterations in nomenclature set down below are due to the researches of Dr. Lütkemüller.

Genus **ROYA** W. & G. S. W. (vol. i, p. 106).

This genus was placed by its discoverers amongst the Placodermæ near to *Closterium*. It was represented as resembling the latter genus very closely, the chief distinction between the two genera being the occurrence of apical vacuoles in *Closterium* and their absence in *Roya*, and furthermore, *Closterium* has usually two chloroplasts with the nucleus in a median position, whereas *Roya* has a single chloroplast with the nucleus in a lateral notch. More recent research has shown that whilst these supposed distinctions do not invariably hold, the two genera are nevertheless less closely related than was at first supposed.

The late Dr. Lütkemüller has pointed out ('Desm. Böhm.' 1910) that *Roya* has a very simple type of cell-wall structure and cannot be allowed to remain amongst the Placoderm Desmids. Its wall is destitute of pores and is a simple cellulose membrane, and Dr. Lütkemüller has therefore suggested that it should be placed among the Saccodermæ near to *Mesotænium*. The position of *Roya* in vol. i, p. 106, next to *Closterium* is therefore erroneous.

With the discovery of the new species, *Roya anglica* West (*vide infra*), the original description of the genus must of necessity be emended, since this species possesses several characters not included in the description given in vol. i, p. 106, *e. g.* the presence

of apical vacuoles, and the concave ends of the chloroplast. The new diagnosis is therefore as follows :

Roya W. & G. S. W. emend. Hodgetts.* Cells unconstricted, cylindrical or subcylindrical, straight or slightly curved, gently attenuated towards the apices, which are more or less truncate or obtusely rounded ; cell wall smooth, colourless, without pores ; chloroplasts one in each cell, or, in old cells, divided at the middle, axile, either rounded at the ends and extending to the apices of the cell, leaving no colourless space, or with concave extremities, in which case the cell has an apical locellus at each end ; nucleus either lateral, lodged in a tiny excavation of the chloroplast, or median, between the two chloroplasts ; pyrenoids several, in a median series.

Roya anglica West.

(Pl. CLXVI, figs. 11–13.)

Roya anglica West, Hodgetts in Journ. Botany, lviii, 1920, p. 69.

Cells cylindrical or subcylindrical, unconstricted, 5–15 (–20) times longer than broad, very slightly tapering towards the apices, which are subtruncate, sometimes straight, but usually slightly asymmetric, a slight regular curvature being present ; greatest width of cell not always in the middle, but more towards one end than the other ; in extreme cases almost clavate in shape ; chloroplast axile with ? 4 longitudinal ridges, usually one in each cell with a slight lateral concavity for the nucleus, afterwards divided at the middle with the nucleus between the two halves ; pyrenoids 4–6 in a longitudinal series ; chloroplasts concave at the extremities, leaving room for an apical vacuole, without moving granules ; cell-wall smooth, colourless, slightly thickened at the apices.

Zygospore globose and smooth.

Length 35–80 (–112) μ ; greatest width 7·5–9 μ ; breadth of apices 5–7 μ ; diam. zygosp. 20–26 μ.

England.—Quinton, near Birmingham, Worcs !

* In 'Journ. Botany,' lviii, p. 69, 1920.

Roya obtusa (Bréb.) W. & G. S. West.

(Pl. CLXVII, fig. 6.)

The zygospores of *R. obtusa* var. *montana* W. & G. S. West (vol. i, p. 108) have been discovered by Harris in Devonshire, and figured by him in 'Journ. Quek. Micr. Club,' 1917, t. 19, f. 11. They are oval, about 20 μ long and 13 μ wide, and are rather different in form from the zygospores of the typical form, which, according to Kirchner, are spherical (*cf.* vol. i, p. 107).

Roya cambrica W. & G. S. W. (vol. i, p. 108).

Forma **limnetica** W. & G. S. W. (Pl. CLXVI, fig. 14).

Roya cambrica forma *limnetica* W. & G. S. W. in Period. Plankt. Brit. Lakes, 1912, p. 430, t. 19, f. 11, 12.

A form with the apices of the cells very truncate.

Length 141–183 μ; breadth (in middle) 6 μ; breadth of apices 4·4–5 μ.

SCOTLAND.—Plankton of Loch Katrine, Perthshire.

Genus **CYLINDROCYSTIS** Bréb.

Cylindrocystis Jenneri (Ralfs) West (vol. i, p. 77).

Penium Jenneri Ralfs in W. & G. S. W. Brit. Desm., vol. i, p. 77.
Cylindrocystis Jenneri (Ralfs) West, Lütkem. Gattung *Penium*, 1905, p. 336.

The possibility of this species belonging to the genus *Cylindrocystis* was suggested in vol. i, p. 78, and that this suggestion was a correct one has been confirmed by Dr. Lütkemüller.

[CYLINDROCYSTIS OBESA W. & G. S. West (vol. i, p. 60) and C. ROSEOLA Turn. (vol. i, p. 62) may according to Lütkem. ('Gattung *Cylindrocystis*,' 1913) remain provisionally in the genus *Cylindrocystis*, but they should be regarded as doubtful species of the genus until they have been examined from the point of view of cell-wall structure. C. DIPLOSPORA Lund., and C. MINUTISSIMA Turn., are to be transferred to the genus *Cosmarium*. *Vide infra*, p. 266.]

Genus **NETRIUM** (Näg.).

Netrium oblongum (De Bary) Lütk. (vol. i, p. 66).

Var. **angustatum** West.

N. oblongum var. *angustatum* West, Clare Island Alg. 1912, p. 9.

Cells distinctly narrower than in the type.
Length 123 μ ; breadth 23 μ.
IRELAND.—Clare Island, Mayo !

Var. **brevius** West.

N. oblongum var. *brevius* West, Clare Island Alg. 1912, p. 9.

Cells about $3\frac{1}{2}$ times longer than broad.
Length 86 μ ; breadth 25 μ.
IRELAND.—Clare Island, Mayo !

Genus **PENIUM** Bréb.

Following the investigations of Dr. Lütkemüller the following species must be removed from the genus *Penium* (see Lütk. 'Gattung *Penium*,' 1905).

PENIUM JENNERI Ralfs (vol. i, p. 77) must now be placed in *Cylindrocystis* (*vide supra*, p. 260).

PENIUM LIBELLULA (Focke) Nordst. (vol. i, p. 73) and P. NAVICULA Bréb. must be transferred to the genus *Closterium* (*vide infra*, pp. 261, 262).

PENIUM ADELOCHONDRUM Elfv. (vol. i, p. 93), P. MOOREANUM Arch. (vol. i, p. 80), P. CLEVEI Lund. (vol. i, p. 87), P. SUBTILE W. & G. S. W. (vol. i, p. 92), P. LAGENARIOIDES Roy (vol. i, p. 93), P. CUCURBITINUM Biss. (vol. i, p. 94), P. CURTUM Bréb. (vol. i, p. 97), P. INCONSPICUUM (vol. i, p. 101) and P. MINUTUM (Ralfs) Cleve (vol. i, p.101) are all to be removed to the genus *Cosmarium* Corda (*vide infra*, pp. 266–268).

Genus **CLOSTERIUM** Nitzsch.

Closterium Libellula Focke (vol. i, p. 73).

Closterium Libellula Focke, Phys. Stud. 1847, p. 58, t. 3, f. 29 ; Lütkem. Gattung *Penium* 1905, p. 337.
Penium Libellula (Focke) Nordst in W. & G. S. W. Brit. Desm. vol. i, p. 73.

Closterium Navicula (Bréb.) Lütkem. (vol. i, p. 75).

Penium Navicula Bréb. in W. & G. S. W. Brit. Desm. vol. i, p. 75.
Closterium Navicula (Bréb.) Lütkem. Gattung *Penium*, 1905, p. 337.

Closterium angustatum Kütz. (vol. i, p. 119).

Var. **angustatum** West.

Cl. angustatum var. *angustatum* West, Clare Isl. Alg. 1912, p. 10, t. 1, f. 5.

Variety with the striations all granular, granules fairly distant, apices of the cell slightly recurved.

Length 457 μ ; breadth 22 μ.

IRELAND.—Near Westport, Mayo !

Closterium Jenneri Ralfs (vol. i, p. 134).

Var. **hibernicum** West.

Cl. Jenneri, var. *hibernicum* West, Clare Isl. Alg. 1912, p. 12.

Cells longer and narrower than in the type, and less strongly curved, about 120° of arc.

Distance between apices 116 μ ; breadth 11 μ ; breadth near apices 4·5 μ.

IRELAND.—Near Westport, Mayo !

Closterium eboracense Turn. (vol. i. p. 140).

Var. **achillense** West.

Cl. eboracense var. *achillense* West, Clare Isl. Alg. 1912, p. 11, t. 1, f. 13, t. 2, f. 16.

Cells always larger than in the type form, with the ventral margin either slightly or distinctly tumid in the median region.

Length 255–290 μ ; breadth 57·5–69 μ.

IRELAND.—Near Dugort, and Slieve more, Achill Isle, Co. Mayo !

Closterium Leibleinii Kütz. (vol. i, p. 141).

Var. **occidentale** West.

Cl. Leibleinii var. *occidentale* West, Clare Isl. Alg. 1912, p. 12.

Cells not tumid in the middle, with the median part

of the inner margin nearly straight, or even slightly concave, cells 138–175° of arc.

Length 137–172 μ; breadth 18·3–25 μ.

IRELAND.—Near Dugort, Achill Isle; near Louisburgh; Doo Lough and near Westport, Mayo!

Closterium tumidum Johns. (vol. i, p. 156).

Var. **sphærospora** West (Pl. CLXVI, figs. 8, 9).

Cl. tumidum var. *sphærospora* G. S. West in Journ. Bot. 1911, p. 84, f. 1.

A variety with short, thick cells.

Zygospore subglobose or ellipsoid-globose.

Length 48–66 μ; breadth 8–8·5 μ; breadth of apex 3–4 μ; diam. zygosp. 23·5–26 μ.

ENGLAND.—Earlswood, Warwickshire!

This variety is distinguished from the typical form of *Cl. tumidum* by its smaller and stouter cells, and the zygospore is rounded, instead of rectangular with produced angles and retuse margins.

Closterium Cornu Ehr. (vol. i, p. 157).

Var. **arcum** West.

Cl. Cornu var. *arcum* West, Clare Isl. Alg. 1912, p. 11.

Cells more strongly curved than in the type, up to 85° of arc, margins only parallel in the middle.

Length 138 μ; breadth 8·5 μ.

IRELAND.—Lough Gall, Achill Isle, Mayo!

Closterium toxon West (vol. i, p. 160).

Var. **validum** West.

Cl. toxon var. *validum* West, Clare Isle Alg. 1912, p. 13, t. 1, f. 6.

Cells twice as thick as in the typical form.

Length 250–260 μ; breadth 17·5–20 μ.

IRELAND.—Clare Isle, Mayo!

Closterium pronum Bréb. (vol. i, p. 173).

Forma **brevius** West.

Cl. pronum f. *brevius* West, Clare Isl. Alg. 1912, p. 13.

Cells always distinctly shorter.
Length 222–250 μ; breadth 8·4–9 μ.
IRELAND.—Clare Isle, Mayo!

Genus **EUASTRUM** Ehrenb.

Euastrum laticolle West.

(Pl. CLXVI, fig. 3.)

Euastrum laticolle G. S. West in Journ. Bot. 1912, p. 89.

Cells of medium size, about $1\frac{1}{3}$ times longer than broad, very deeply constricted, sinus extremely narrow and linear; semicells 3-lobed, lobes separated by broad and shallow concavities; lateral lobes trapeziform with the upper and lower angles gently rounded, sides diverging upwards and slightly concave; polar lobe transversely subrectangular, angles scarcely rounded and slightly produced, apex convex, but retuse in the middle; with a small swelling in the middle of the semicell near the isthmus. Vertical view transversely subhexagonal-rectangular, with a subconical protuberance in the middle of each side, ends concave, and with the two angles at each end rounded, margins between the central tumour and the polar angles broadly concave; polar lobe transversely subrectangular, angles subrotund and sides slightly concave. Cell-wall irregularly and somewhat distantly punctate.

Zygospore unknown.

Length 58 μ; breadth 44 μ; breadth of polar lobe 26 μ; breadth of isthmus 10 μ; thickness 30 μ.

ENGLAND.—In a bog at Lindeth, near Bowness, Westmoreland!

This is a very distinctive species, its only near relative being *E. Berlini* Boldt (in 'Desm. Grönland,' 1888, p. 10, t. i, f. 12), a

Desmid only known from Grönnedal in South Greenland. From this, Arctic Desmid *E. laticolle* differs in the form of the front view, having a closed and linear sinus, and lateral lobes of quite a different shape. The general outline of the vertical view is the same as in *E. Berlini*, but in the latter species the polar lobe is described (and also figured) by Boldt as "broadly elliptical" when seen in the end view, whereas that of *E. laticolle* is rectangular with retuse sides and rounded angles.

Euastrum affine Ralfs (vol. ii, p. 17).

Forma **scrobiculata** Nordst.

Euastrum affine f. *scrobiculata* Nordst. Norges Desm. 1873, p. 8; Harris, in Journ. Quek. Micr. Club, 1917, p. 259.

The chief distinction of this form is the presence of a conspicuous ocellation in the middle of the semicell, which takes the place of the two upper tumours.

ENGLAND.—Devonshire (*Harris*).

Euastrum montanum West (vol. ii, p. 58).

(Pl. CLXVII, fig. 5.)

The zygospore of *Euastrum montanum* has been figured by Lütkemüller ('Zur K. d. Desm. Böhm.' 1910, p. 483). It is spherical with numerous tubercles, each tubercle ending in a simple hooked spine. Diam. zygosp. without spines, 29 μ; including spines 44 μ.

Euastrum insulare (Wittr.) Roy (vol. ii, p. 68).

Var. **parvum** West.

Eu. insulare var. *parvum* West, Clare Isl. Alg. 1912, p. 15.

Cells similar to the typical form, but smaller, and relatively shorter, margins of lateral lobes less retuse.

Length 12·5–17 μ; breadth 10–13 μ.

IRELAND.—Near Dugort, Achill Isle, and near Castlebar, Mayo!

Genus **MICRASTERIAS** Ag.

Micrasterias papillifera Bréb. (vol. ii, p. 91).

(Pl. CLXVII, fig. 11.)

Zygospore compressed, globose in front view, broadly oval in lateral view, with numerous strong spines, simple or slightly furcate at the apex. Diam. zygosp., without appendages, 85 μ; including appendages, 138 μ; thickness, without appendages, 69 μ; including appendages, 115 μ.

[The figure of the zygospore on Pl. XLIV, fig. 7, is not good, and the dimensions for the zygospore given in vol. ii, p. 92, are obviously erroneous. The compressed form of the spore has not been previously noted, and the appendages are not identical with those figured by Ralfs.]

Genus **COSMARIUM** Corda.

Cosmarium diplosporum (Lund.) Lütk. (vol. i, p. 61).

Cylindrocystis diplospora Lund. Desm. Suec. 1871, p. 83, t. 5, f. 7; W. & G. S. West, Brit. Desm. vol. i, p. 61.
Cosmarium diplosporum Lütkem. Gattung *Cylindrocystis*, 1913, p. 227.

Cosmarium pseudarctoides Ström (vol. i, p. 62).

Cylindrocystis minutissima Turn. Freshw. Alg. E. India, 1893, p. 16, t. 1, f. 24; W. & G. S. West, Brit. Desm. vol. i, p. 62.
Cosmarium pseudarctoides Ström Alg. Tuddal, 1920, p. 31.

Ström has observed spores in the cell-wall of this tiny Desmid, and for this reason transferred it to the genus *Cosmarium*. Lütkemüller ('Gattung *Cylindrocystis*'), 1913, considered it to be a doubtful species of *Cylindrocystis*.

Cosmarium Mooreanum (Arch.) Lütk. (vol. i, p. 80).

Penium Mooreanum Arch. Descr. New Cosm. etc. 1864, p. 24, t. 1, f. 34–44; W. & G. S. W. Brit. Desm. vol. i, p. 80.
Dysphinctium Mooreanum Lütkem. Gattung *Penium*, 1905, p. 337.
Cosmarium Mooreanum Lütkem. Zur. K. Desm. Böhmens, 1910, p. 490.

Cosmarium Clevei (Lund.) Lütk. (vol. i, p. 87).

Penium Clevei Lund. Desm. Suec. 1871, p. 86, t. 5, f. 11 ; W. & G. S. W. Brit. Desm. vol. i, p. 87.
Dysphinctium Clevei De Toni in Lütkem. Gattung *Penium*, 1905, p. 337.
Cosmarium Clevei (Lund.) Lütk. Zur K. Desm. Böhmens, 1910, p. 486.

Cosmarium subtile (West) Lütk. (vol. i. p. 92).

Penium subtile W. & G. S. West. Brit. Desm. vol. i, p. 92.
Dysphinctium subtile Lütk. Gattung *Penium*, 1905, p. 337.
Cosmarium subtile Lütkem. Zur K. Desm. Böhmens. 1910, p. 494.

Cosmarium adelochondrum (Elfv.) Lütk. (vol. i. p. 93).

Penium adelochondrum Elfv. Anteck. Finska. Desm. 1881, p. 17, t. 1, f. 13.
Dysphinctium adelochondrum Lütkem. Gattung *Penium*, 1905, p. 337.
Cosmarium adelochondrum Lütkem. Zur K. Desm. Böhmens, 1910, p. 483.

Cosmarium lagenarioides* (Roy) Lütk. (vol. i, p. 93).

Penium lagenarioides Roy in Biss. Desm. Windermere, 1884, p. 197, t. 5 W. & G. S. W. Brit. Desm. vol. i, p. 93.
Dysphinctium lagenarioides Lütkem. Gattung *Penium*, 1905, p. 337.

Cosmarium cucurbitinum (Biss.) Lütk. (vol. i, p. 94).

Penium cucurbitinum Biss. Desm. Windermere, 1884, p. 197, t. 5, f. 7 ; W. & G. S. W. Brit. Desm. vol. i, p. 94.
Dysphinctium cucurbitinum Lütkem. Gattung *Penium*, 1905, p. 337.
Cosmarium cucurbitinum Lütkem. Zur K. Desm. Böhmens, 1910, p. 487

Cosmarium curtum (Bréb.) Ralfs (vol. i. p. 97).

Closterium curtum, Bréb. 1838.
Cosmarium curtum (Bréb.) Ralfs, Brit. Desm. 1848. p. 109, t. 32, f. 9.
Penium curtum Bréb. in W. & G. S. W. Brit. Desm. vol. i, p. 97.
Dysphinctium curtum (Bréb.) Näg. Lütkem. Gattung *Penium*, 1905, p. 337.

Cosmarium bacillare Lütk. (vol. i, p. 101).

Penium inconspicuum West, Brit. Desm. vol. i, p. 101, t. 10, f. 15–17.
Dysphinctium inconspicuum Lütkem. Gattung *Penium*, 1905 p. 337.
Cosmarium bacillare Lütkem. Zur K. Desm. Böhmens. 1910, p. 484.

* The writer believes this to be the first time that this species has been published under this name. In his paper, 'Zur K. Desm. Böhmens,' 1910, however, Lütkemüller states that all the species listed by him under *Dysphinctium* in 'Gattung *Penium*,' 1905, p. 337, should really be placed in *Cosmarium*. It is therefore transferred with his authority.

Cosmarium docidioides Lütk. (vol. i, p. 101).

Docidium minutum Ralfs, Brit. Desm. 1848, p. 158, t. 26, f. 5.
Penium minutum W. & G. S. West, Brit. Desm. vol. i, p. 101.
Dysphinctium minutum Lütkem. Gattung *Penium*, 1905, p. 337.
Cosmarium docidioides Lütkem. in litt.; G. S. West, Freshw. Alg. Columbia, 1914, p. 1037.

Cosmarium Ralfsii Bréb. (vol. ii, p. 141).

Var. **rotundatum** West.

Cosmarium Ralfsii var. *rotundatum* West, Clare Island Alg. 1912, p. 19, t. 2, f. 19.

A variety with very rounded lateral margins to the semicells, basal angles sometimes very slightly produced, sinus nearly closed.

Length 110 μ; breadth 100 μ; breadth of isthmus 24 μ.

IRELAND.—Near Westport, Mayo!

Cosmarium depressum (Näg.) Lund. (vol. ii, p. 176).

Var. **minor** West.

Cosmarium depressum var. *minor* West, Clare Island Algæ, 1912, p. 19.

Cells smaller than in the type.

Length 26 μ; breadth 20 μ.

IRELAND.—Clare Island, Mayo!

Cosmarium anceps Lund. (vol. iii, p. 47).

Var. **tatricoides** West.

Cosmarium anceps var. *tatricoides* West, Clare Island Algæ, 1912, p. 16.

Cells relatively broader than in the typical form, isthmus compressed, but similar to that of *C. tatricum* Racib. (that is, narrow, with conspicuously dilated apex), cell-wall smooth.

Length 33 μ; breadth 21 μ.

IRELAND.—Clare Isle, Mayo!

Cosmarium Brebissonii Menegh (vol. iii, p. 161).

The zygospore of *Cosmarium Brebissonii* has been figured by Harris in 'Journ. Quek. Micr. Club.' 1917, t. 19, f. 10, from Devonshire. It is spherical, about 50 μ in diameter, and covered with broad rounded tubercles, about 14 of which are to be seen round the periphery.

Genus **STAURASTRUM** Meyen.

Staurastrum Meriani Reinsch (vol. iv, p. 122).

(Pl. CLXVII, figs. 8, 9.)

Zygospore compressed, circular in front view, with 10–12 marginal crenations. Diam. 45·5 μ; thickness 27 μ.

[This zygospore is almost identical with that of *St. striolatum* (Näg.) Arch., see vol. iv, Pl. CXXVII, figs. 3–5.]

Staurastrum brevispinum Bréb. (vol. iv, p. 145).

(Pl. CLXVI, fig. 2.)

Zygospore spherical, membrane smooth. Diam. 45 μ.

[These zygospores were found by Mr. W. J. Hodgetts, from whose preparations the figure given was made.]

Additional Synonyms.

Closterium Ceratium Perty (vol. i, p. 176), includes *Cl. fasciculatum* Rabenh. Alg. Eur. no. 2163, 1870.

Euastrum binale (Turp.) Ehr. f. Gutwinskii Schmidle (vol. ii, p. 53) includes *Eu. venustum* Hantzsch, Rabenh. Alg. Eur. no. 1543, 1863.

Cosmarium speciosum Lund. 1870 (vol. iii, p. 247) includes *C. Heuflerianum* Grun. in Rabenh. Flor. Eur. Alg. 1868, p. 172; De Toni, Syll. Alg. 1889, p. 1053.

INDEX TO VOLS. I—V.

Roman numerals indicate the volumes; page numbers in black type refer to descriptions or diagnoses.

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EXPLANATIONS OF THE PLATES.

EXPLANATION OF THE LETTERING.

a, *a′*, *a″*. Front view of cell or semicell

b, *b′*. Vertical view.

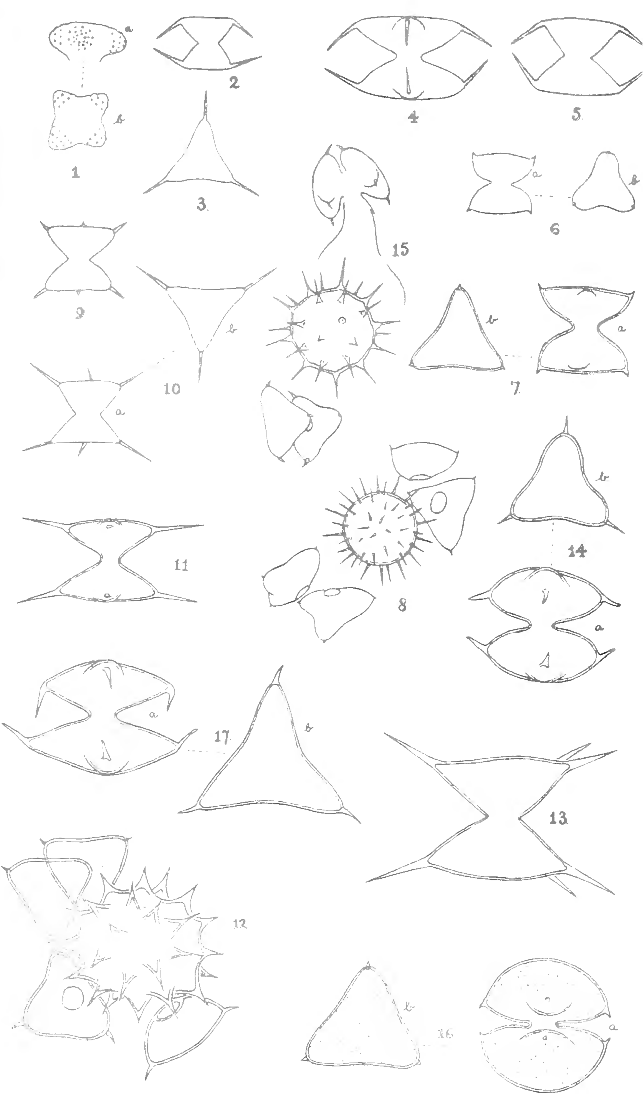
c. Side view.

d. Basal view of semicell.

[*The asterisk * denotes that the figure so marked is original by the Author, and is not from the pencil of Professor West.*]

Plate 129

PLATE CXXIX.

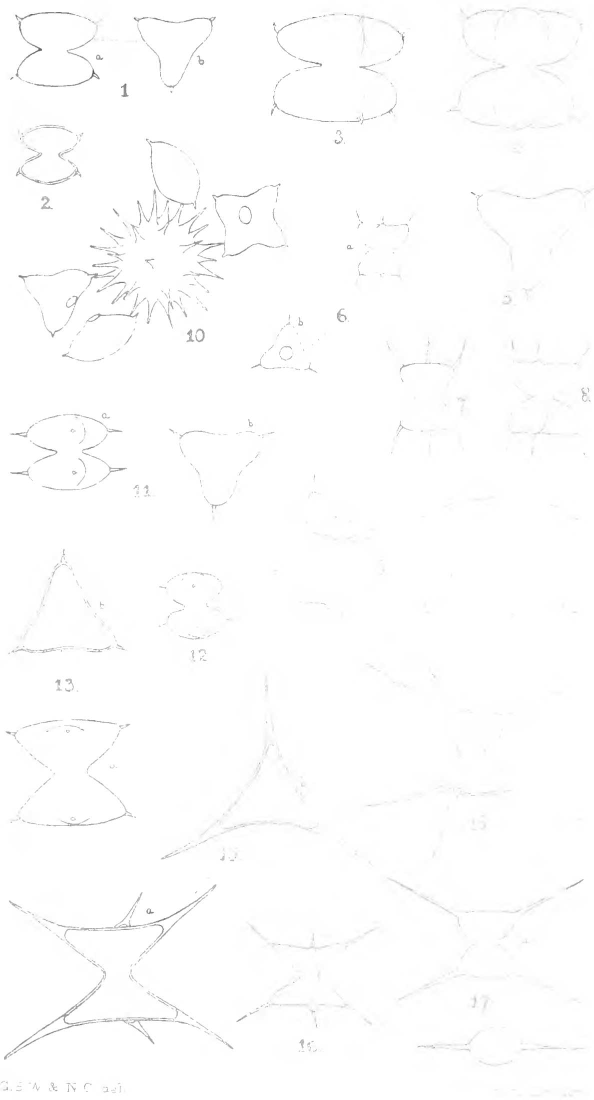


G S W & N C del

Huth, London.

Plate 130

PLATE CXXX.



G. S. W. & N. C. del.

Plate 131

PLATE CXXXI.

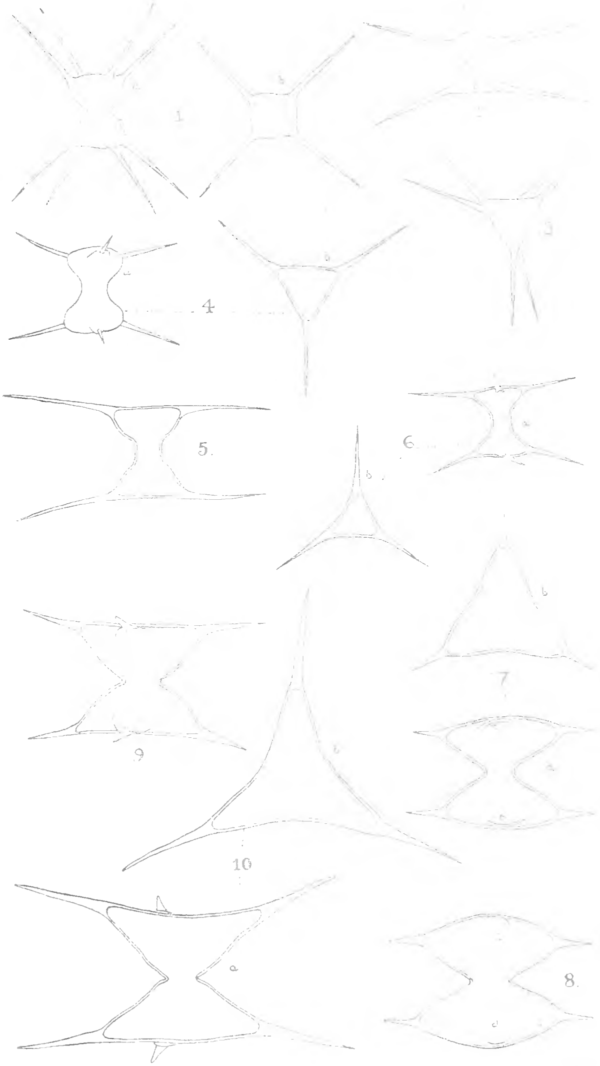


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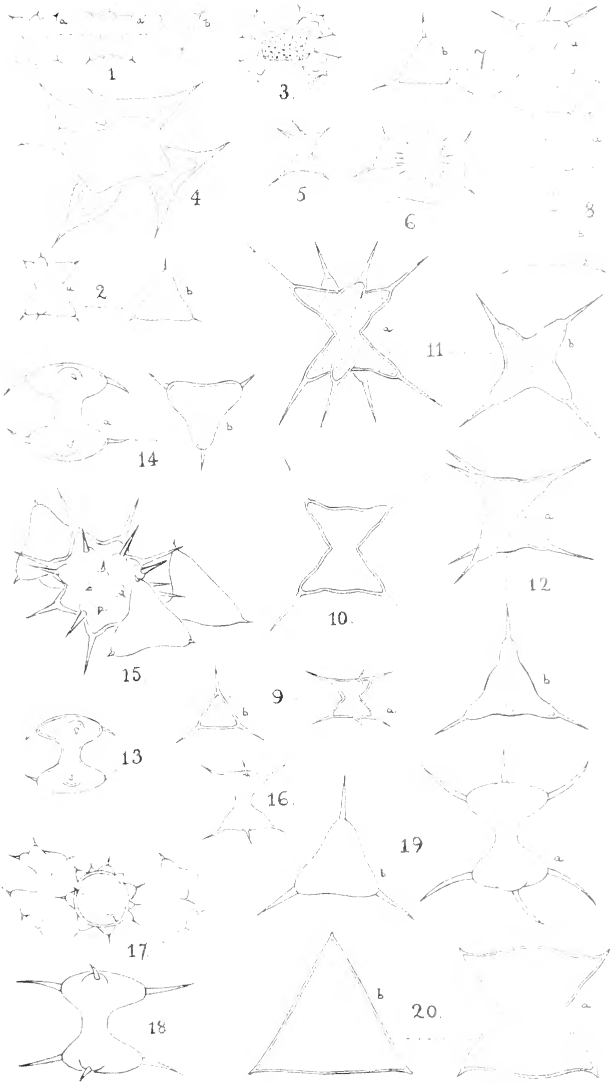
Plate 132

PLATE CXXXII.



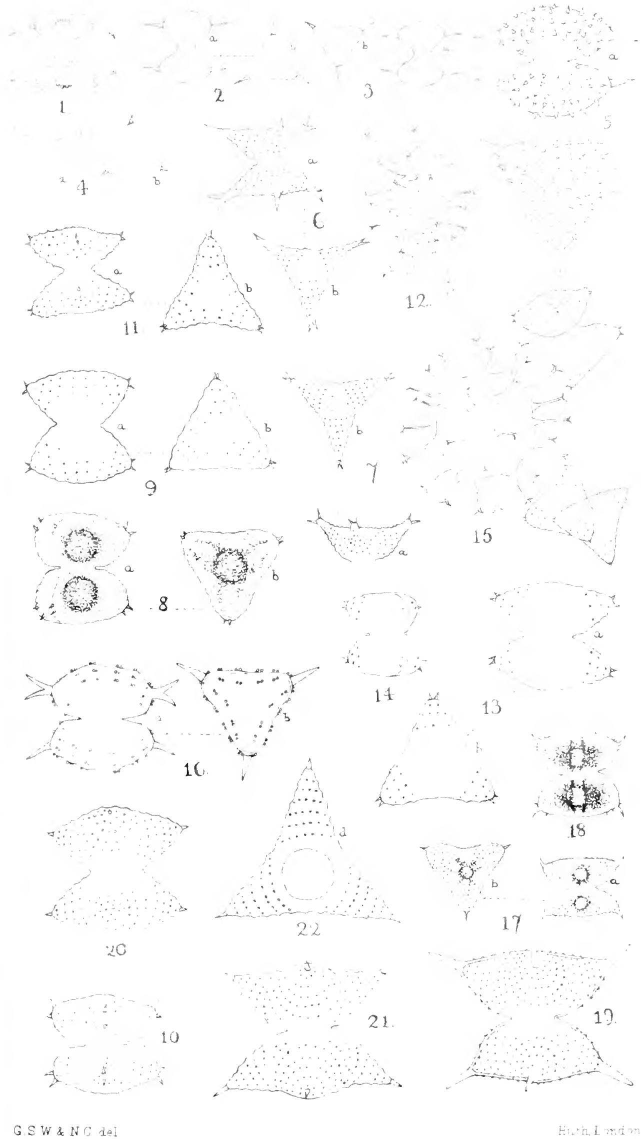
G. S. W. & N. C. del.

Huth, London

Plate 133

PLATE CXXXIII.

PLATE CXXXIII



G.S.W. & N.C. del.

Huth, London

Plate 134

PLATE CXXXIV.

FIGS.		PAGE
1*.	—*Staurastrum longispinum* (Bail.) Arch. × 510	33
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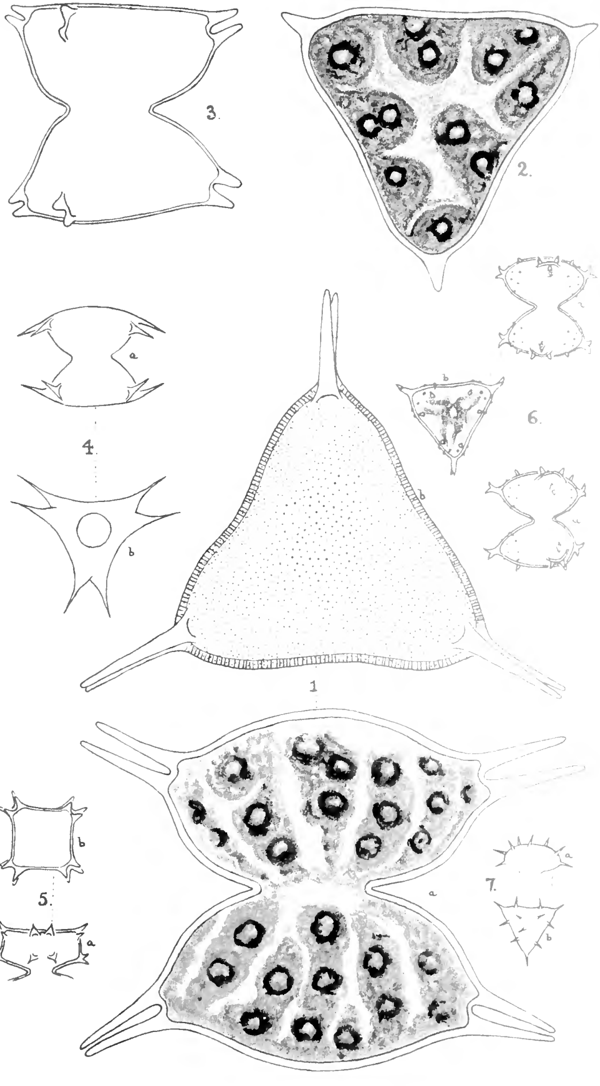

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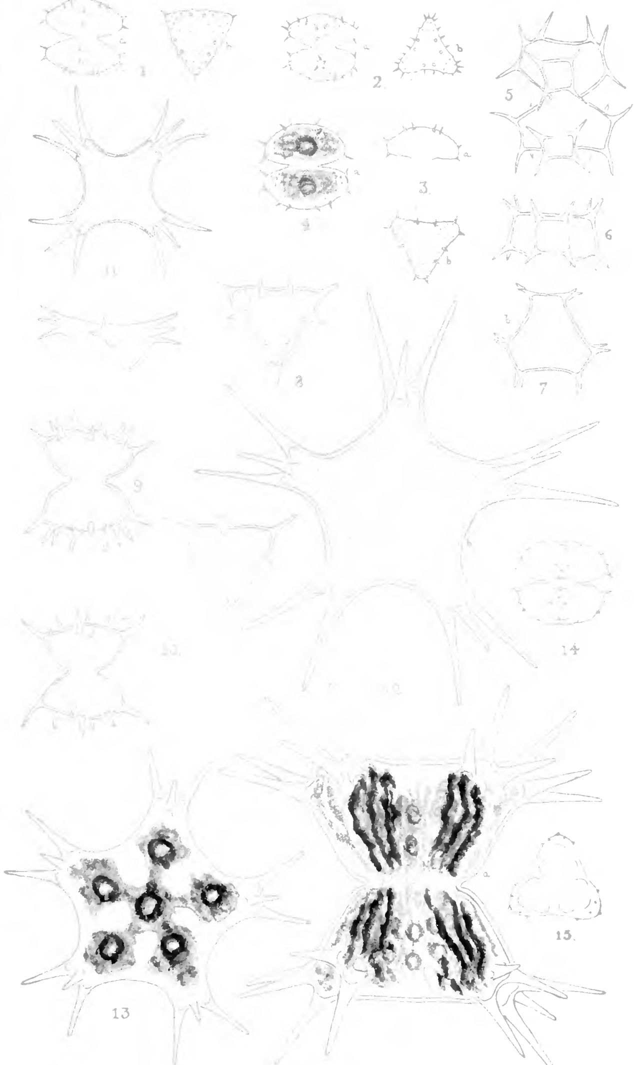
PLATE CXXXV



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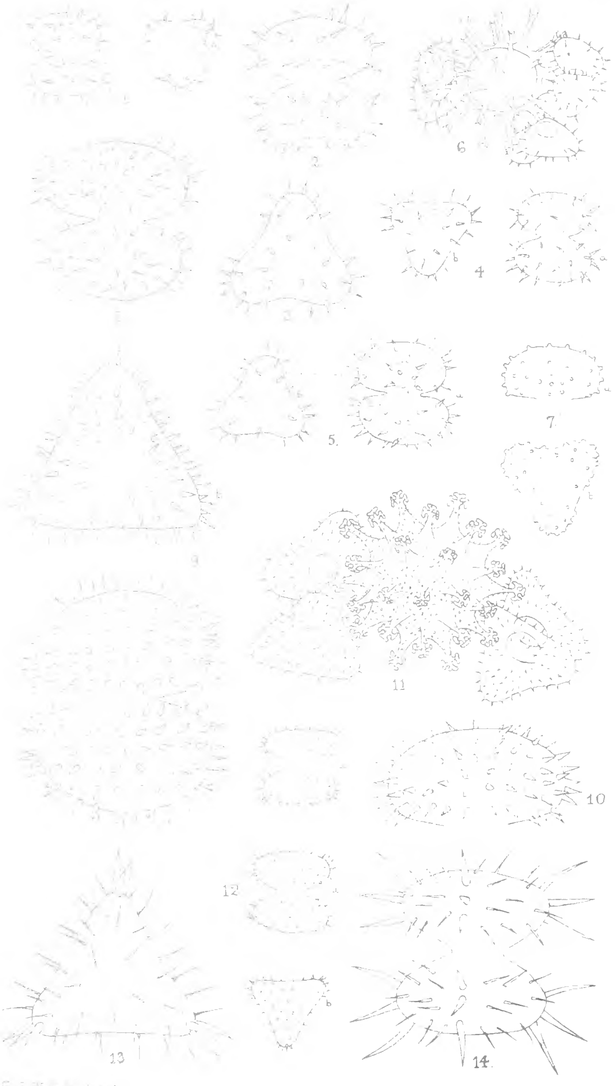

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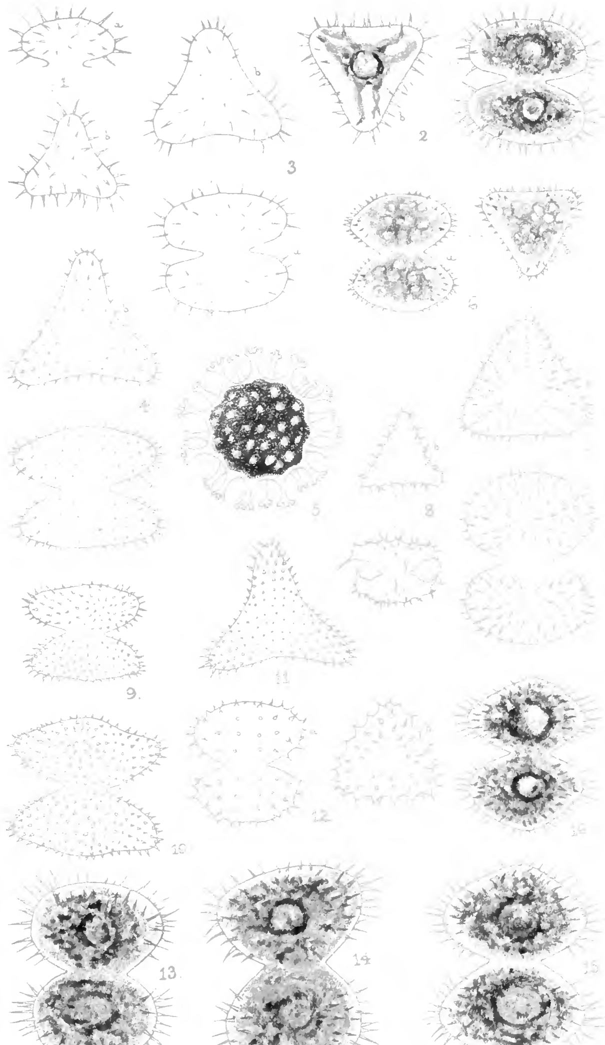

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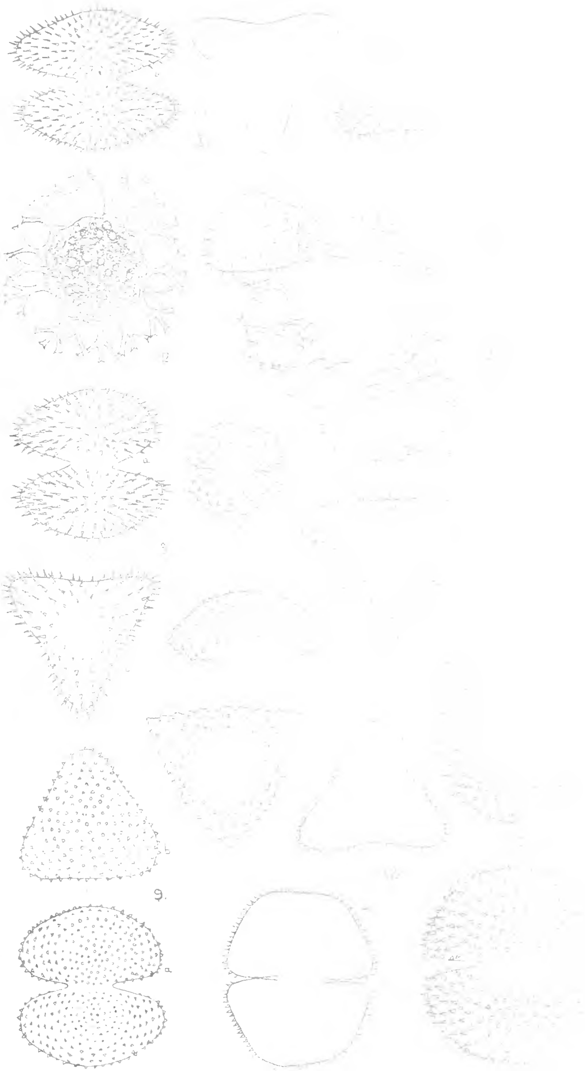

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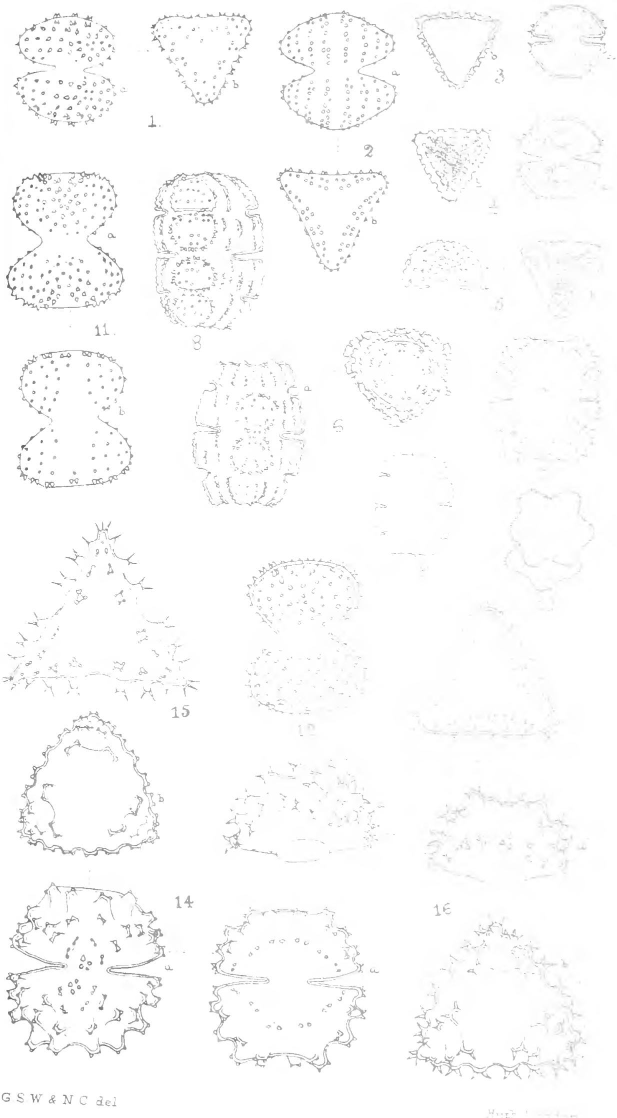

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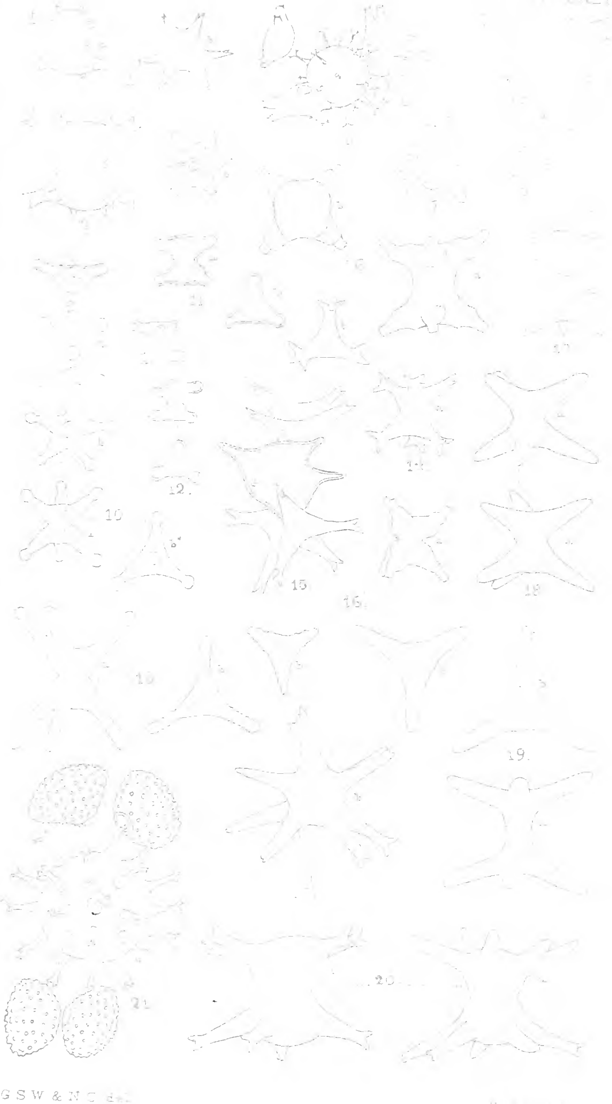

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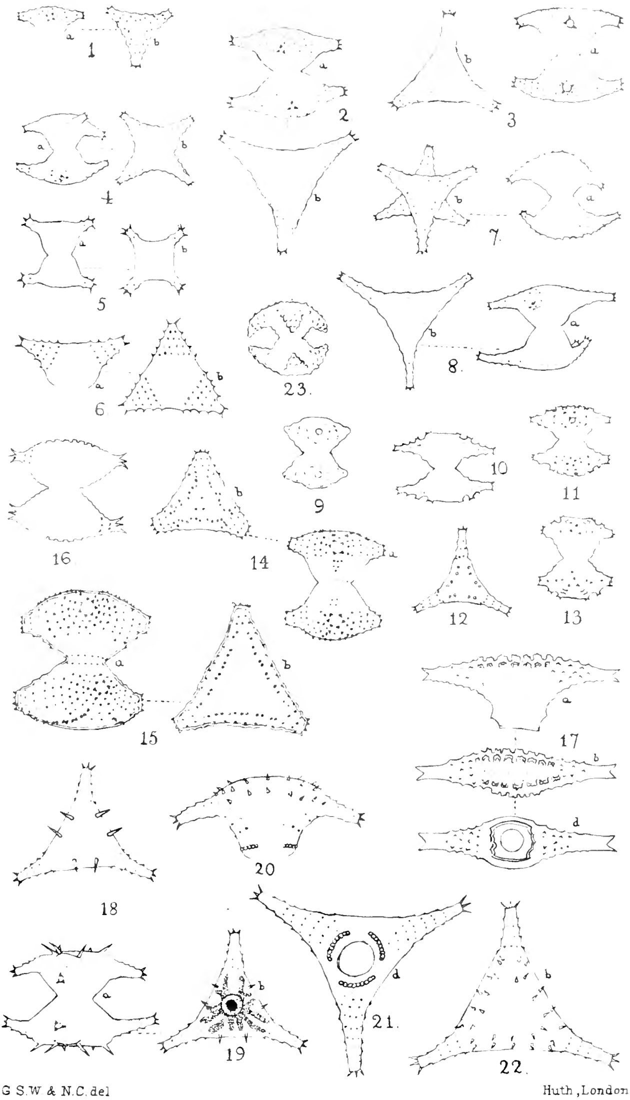

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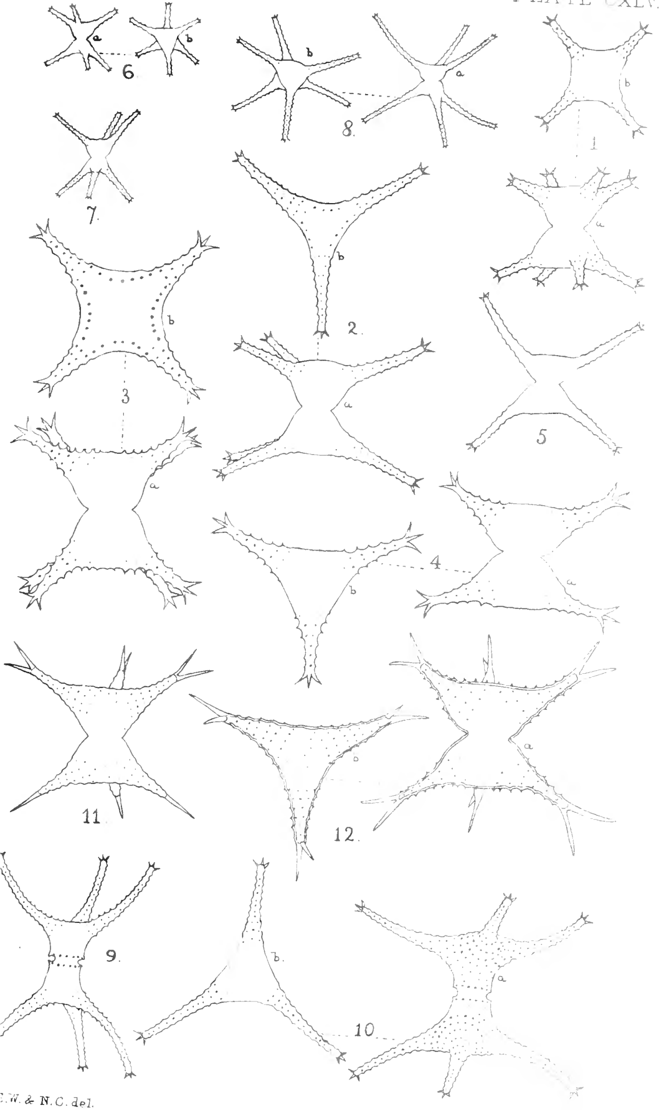

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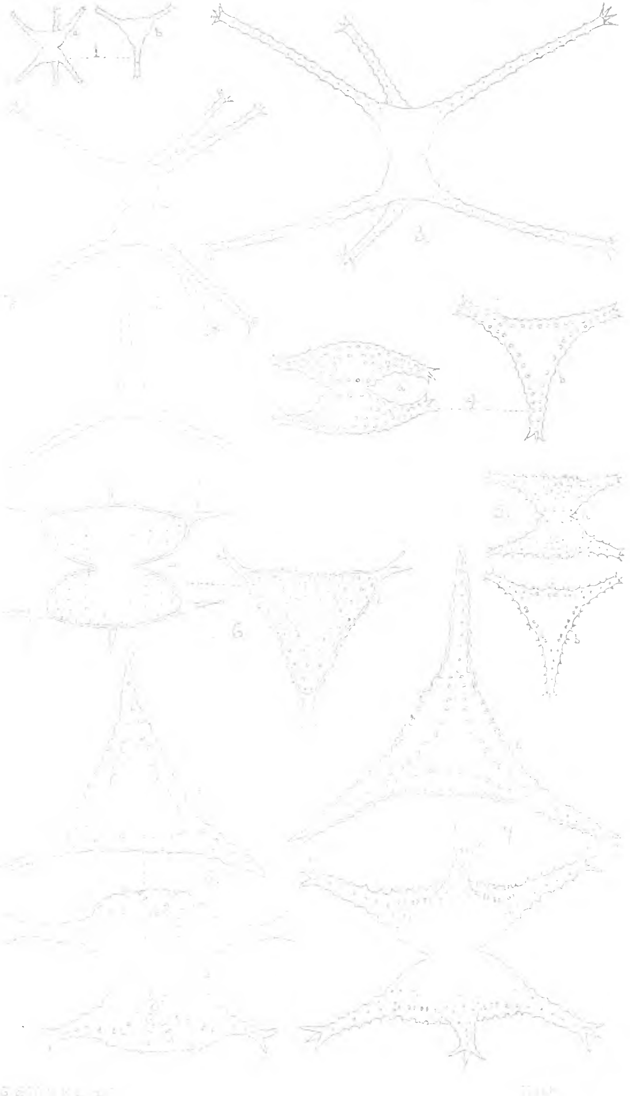

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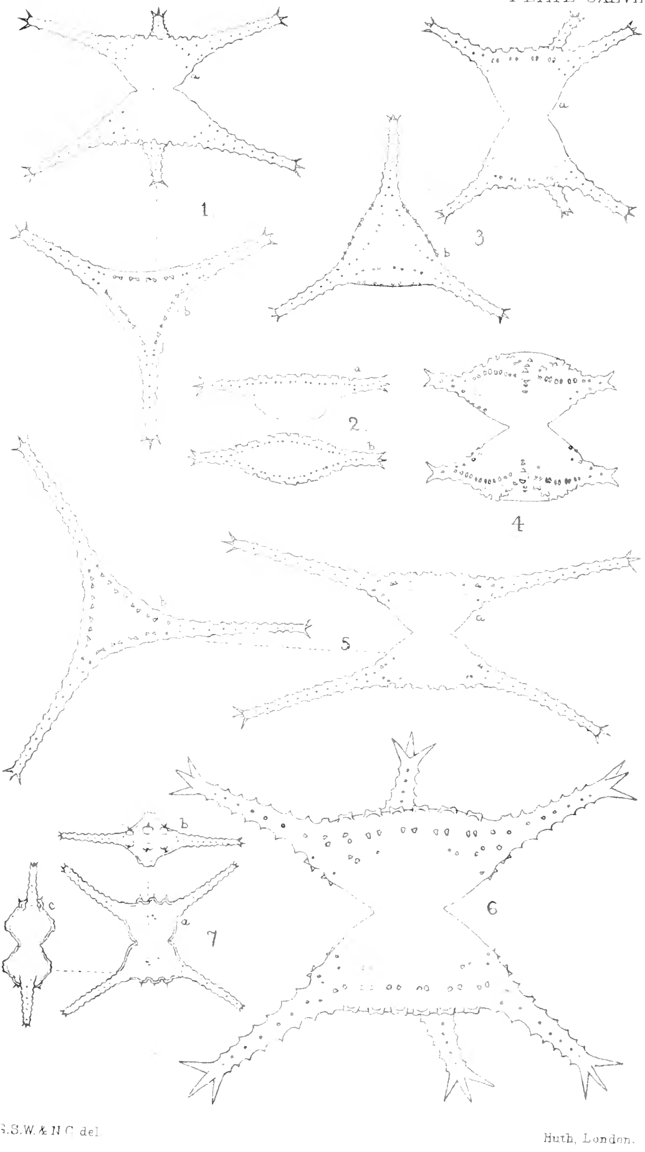

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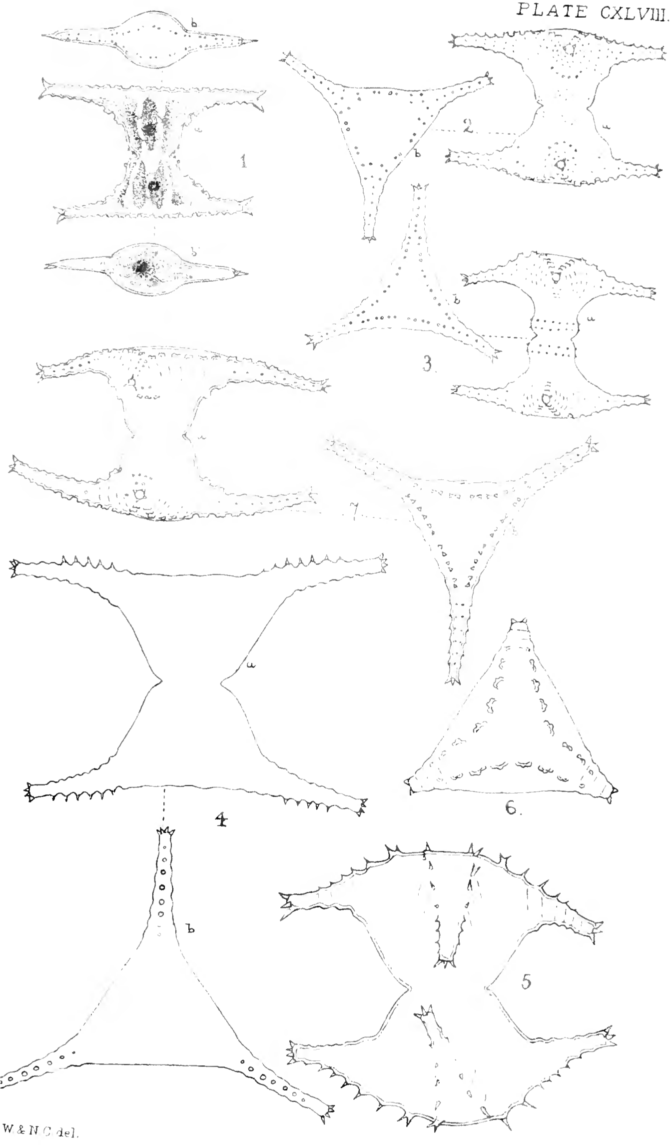

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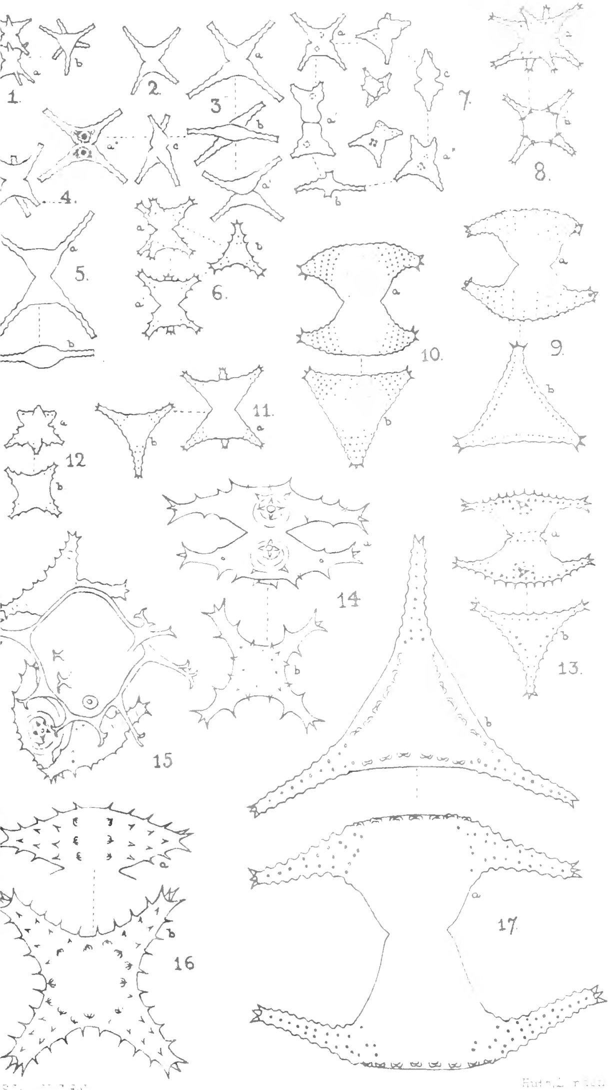
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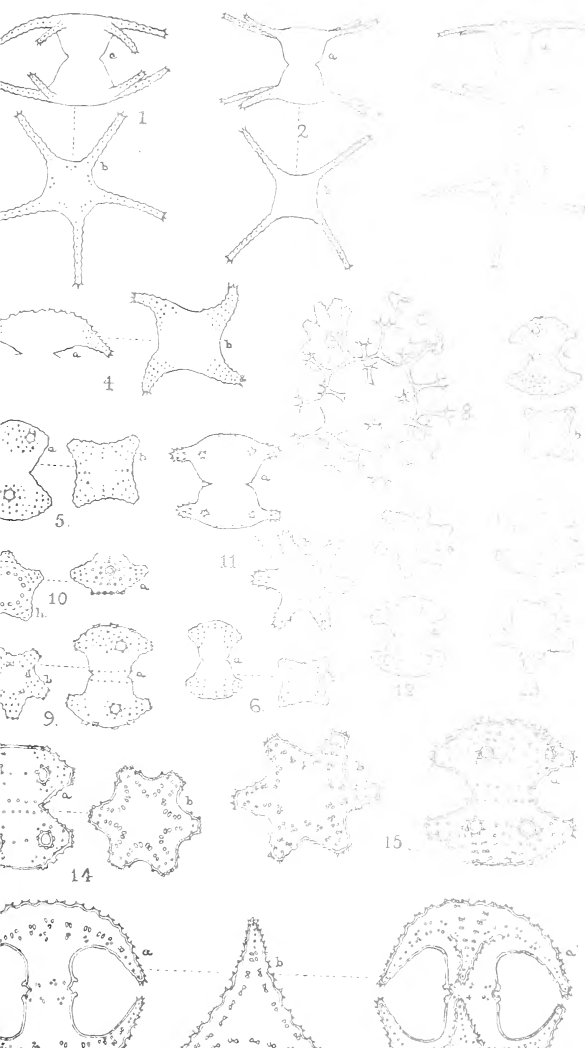
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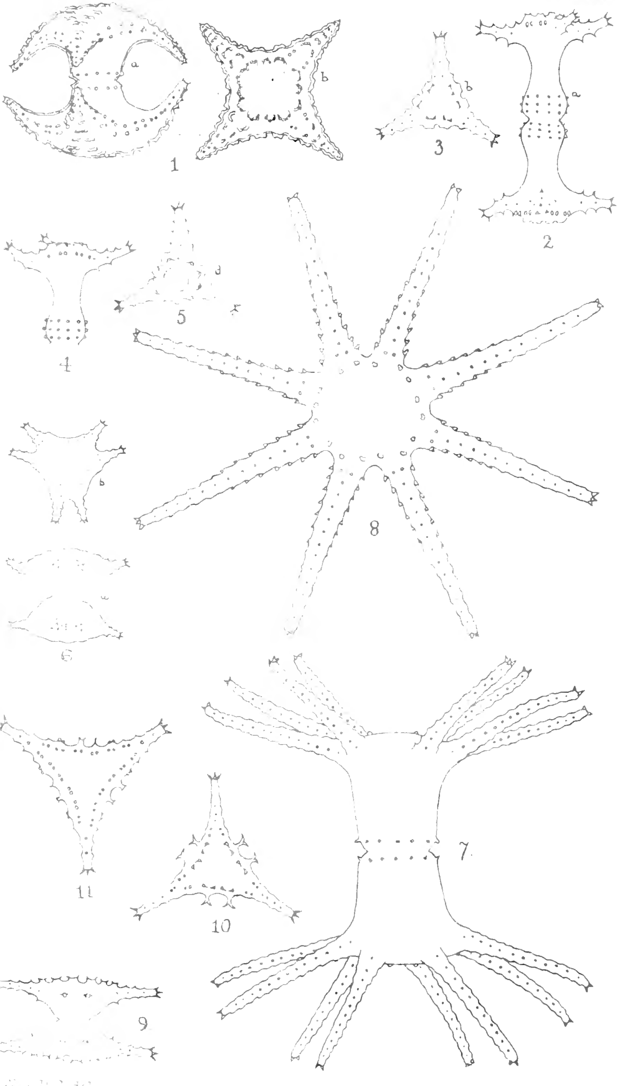

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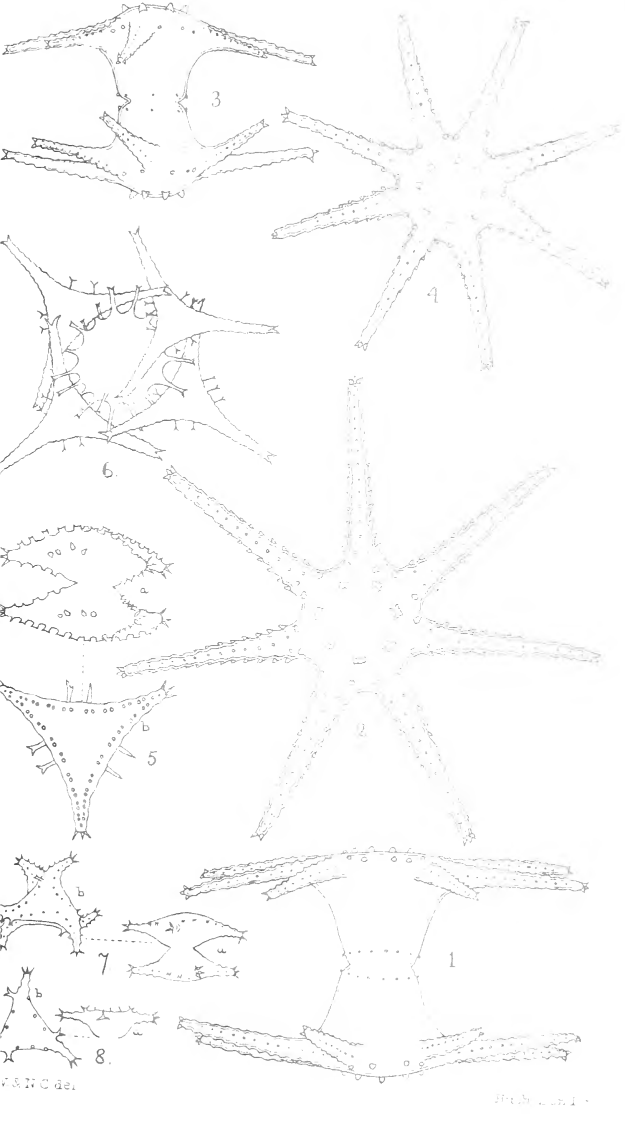

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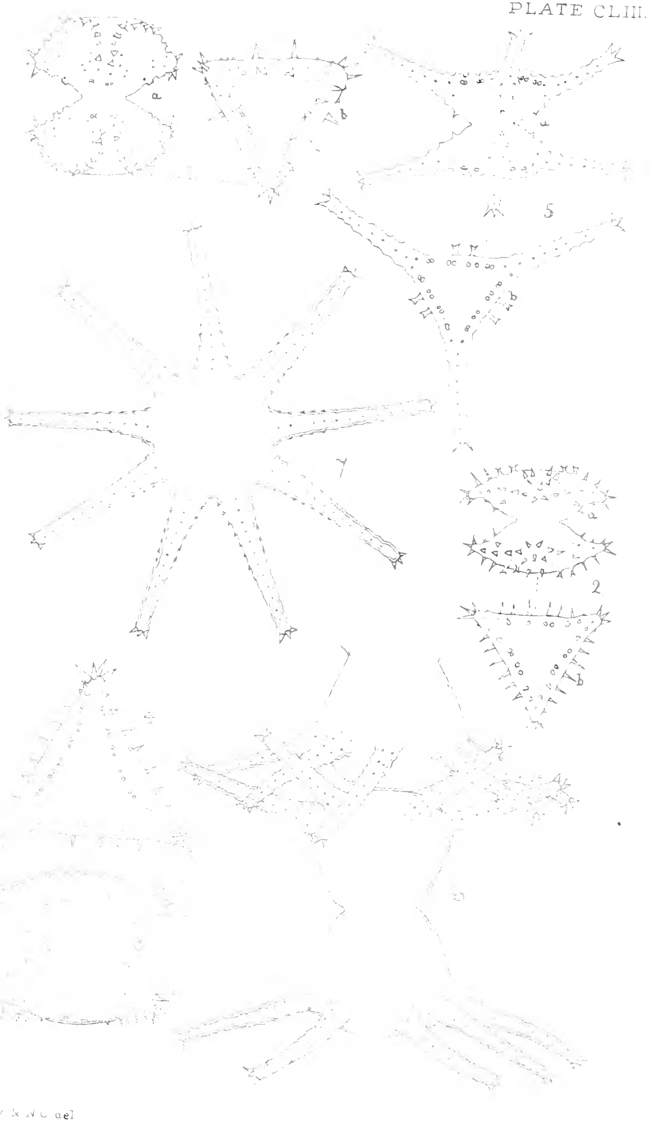

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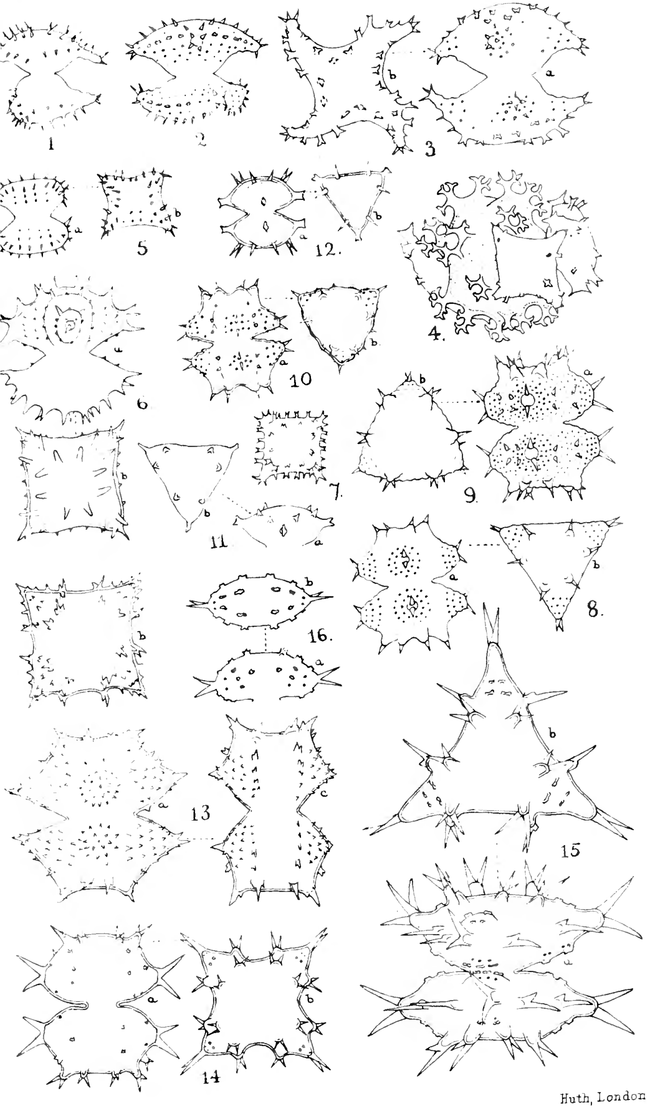

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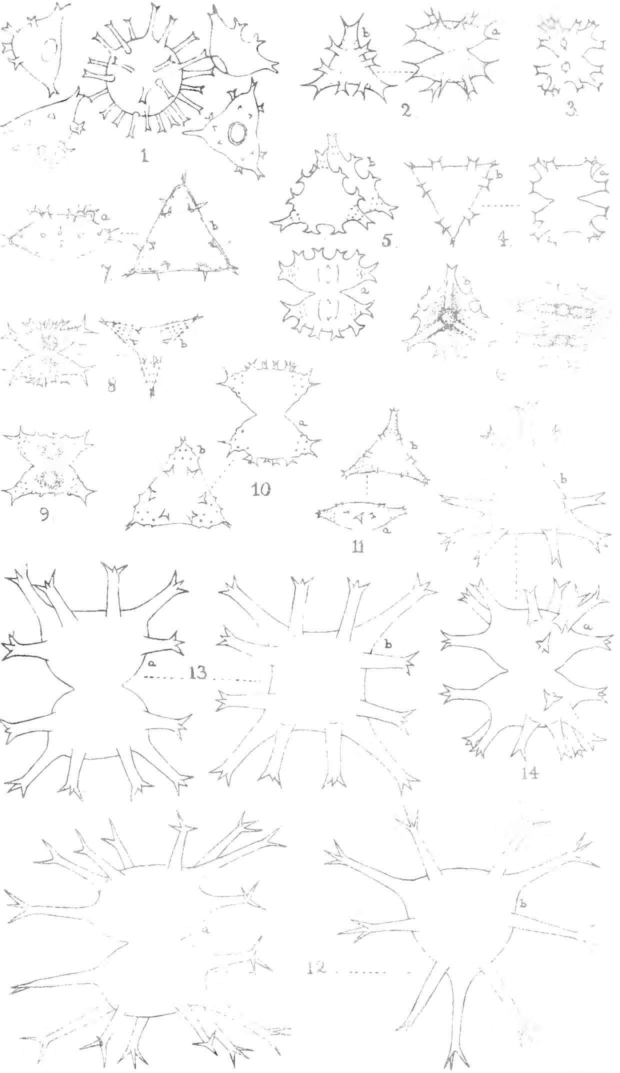
PLATE CLV



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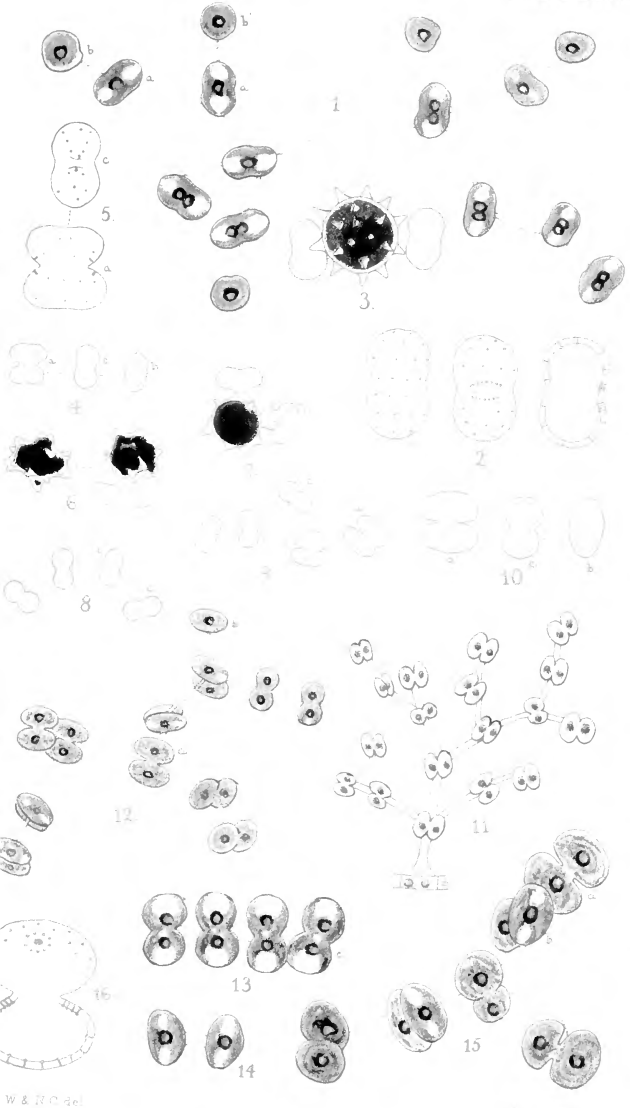

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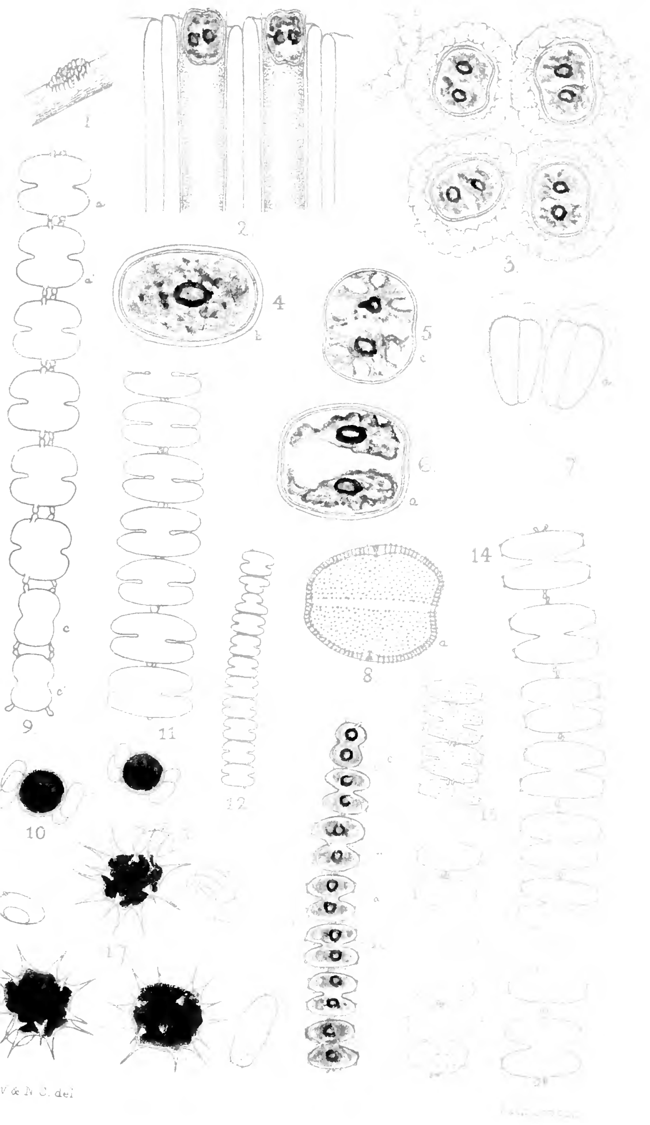

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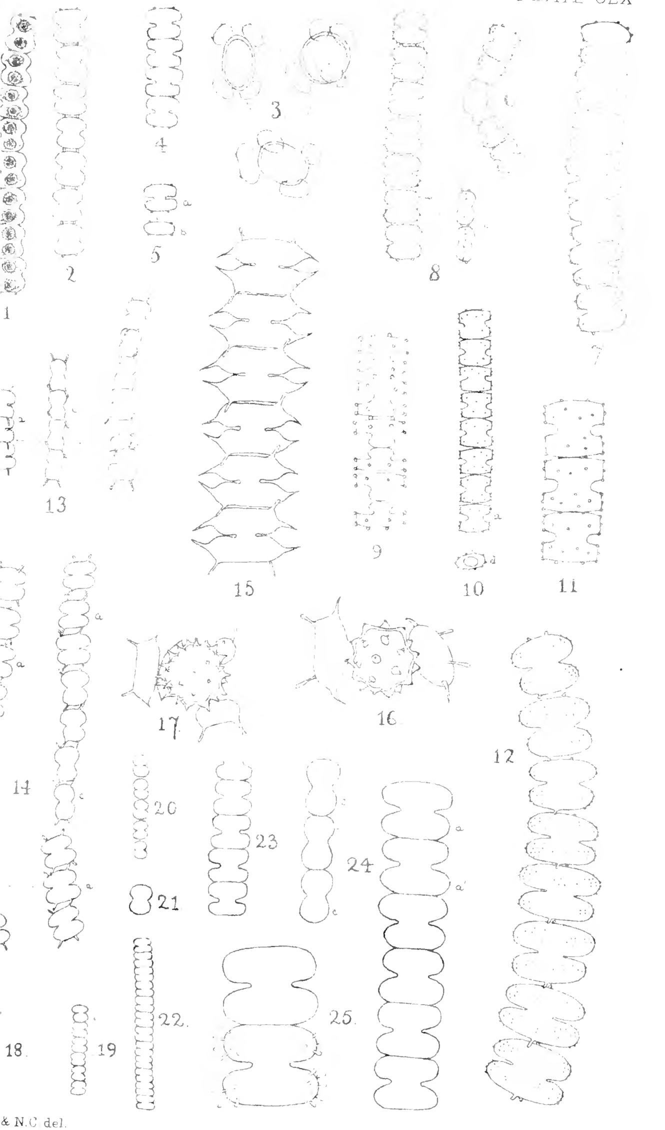

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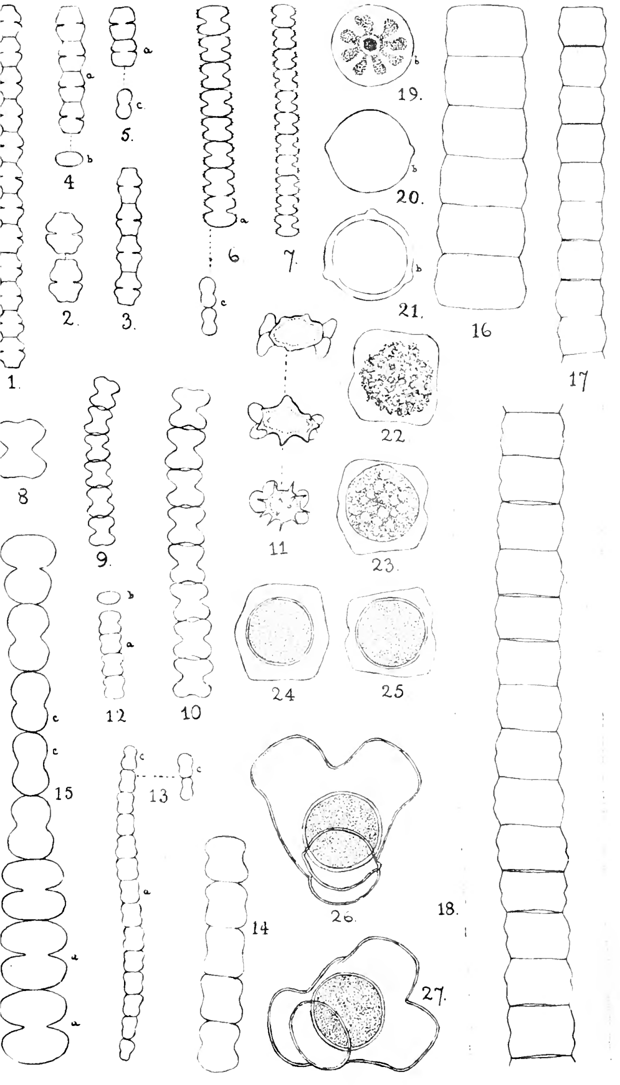

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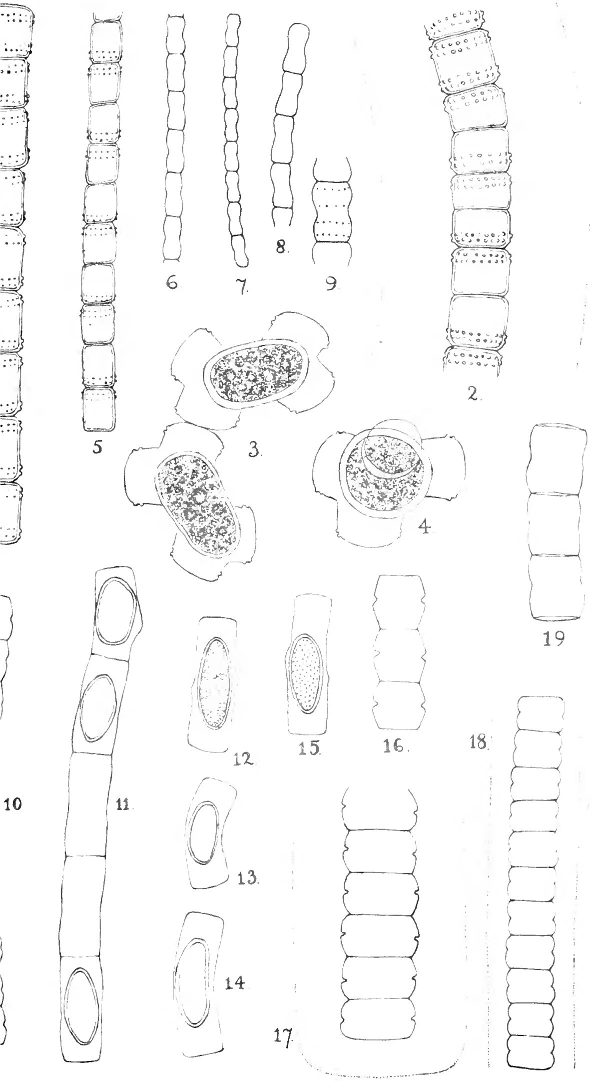

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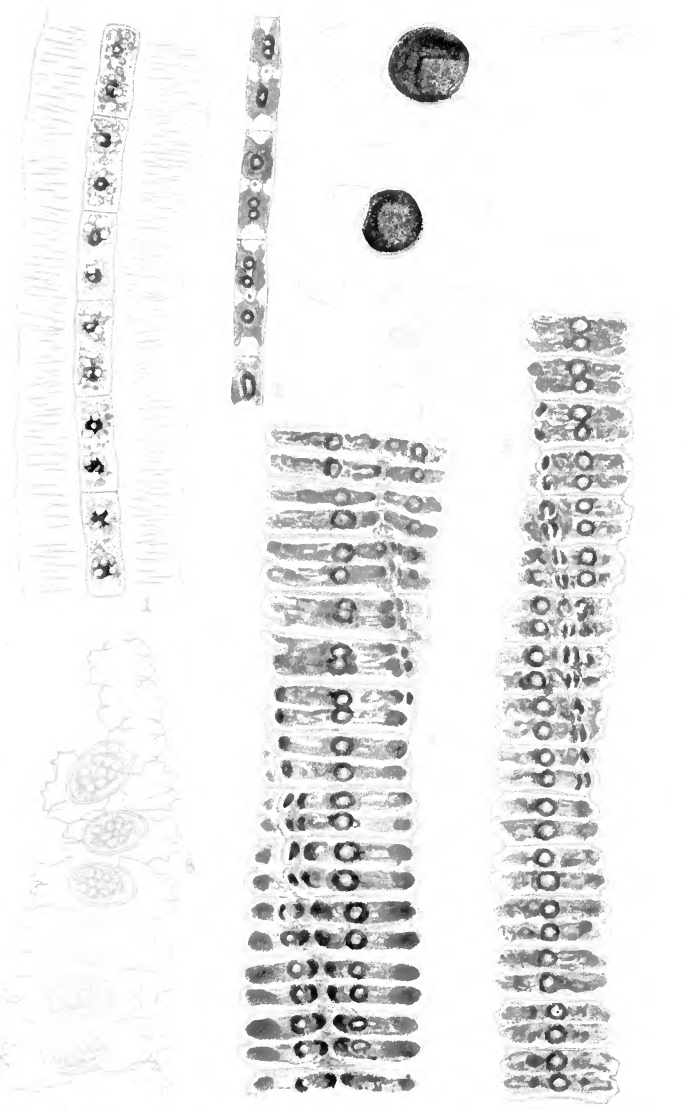

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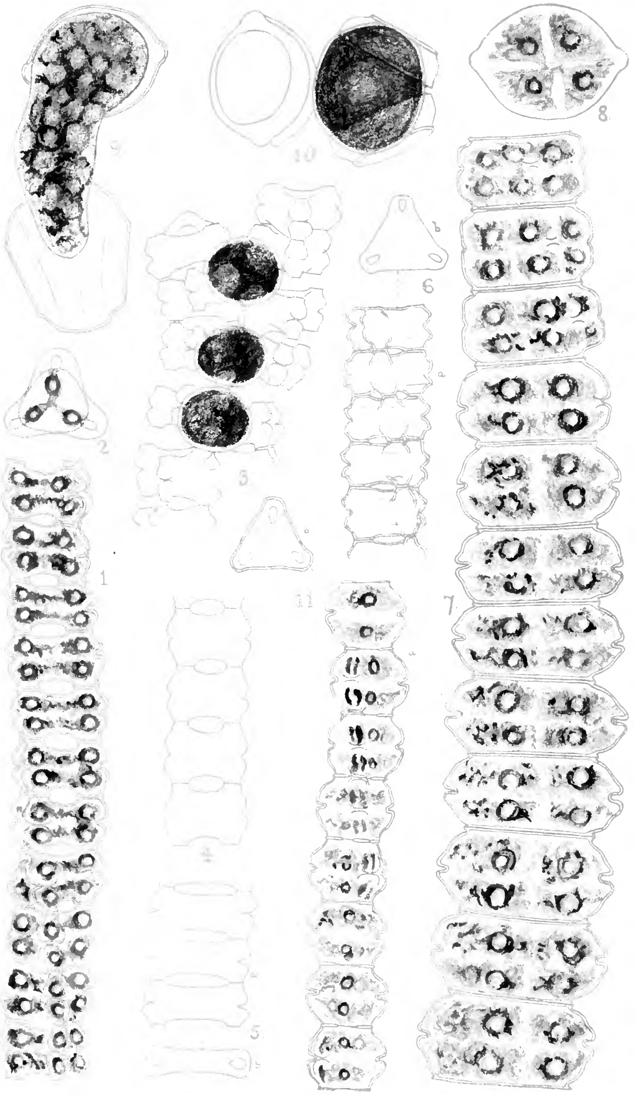
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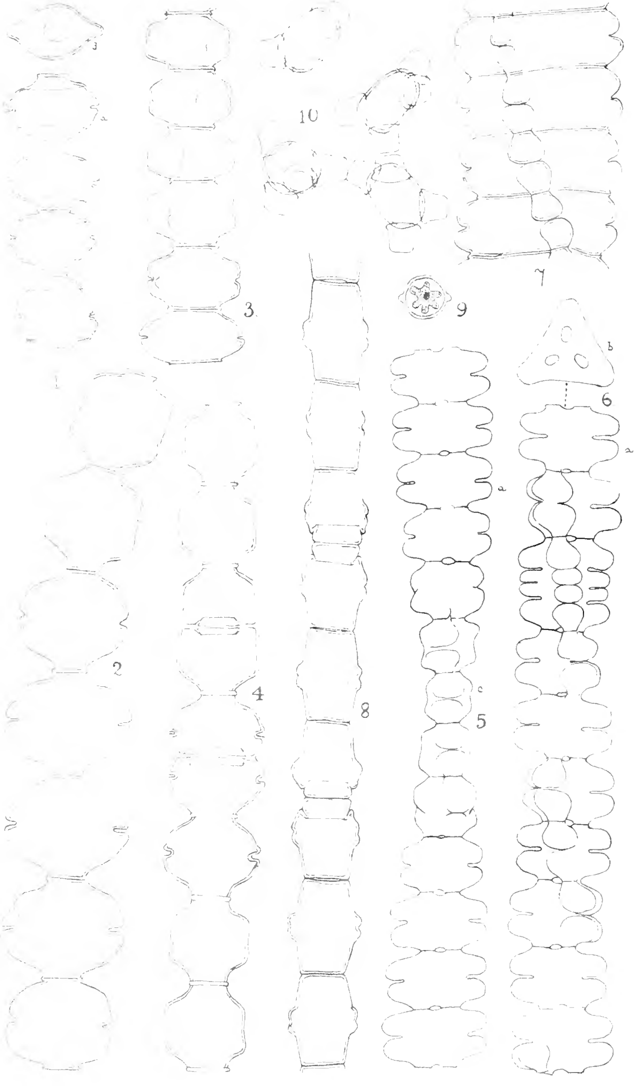

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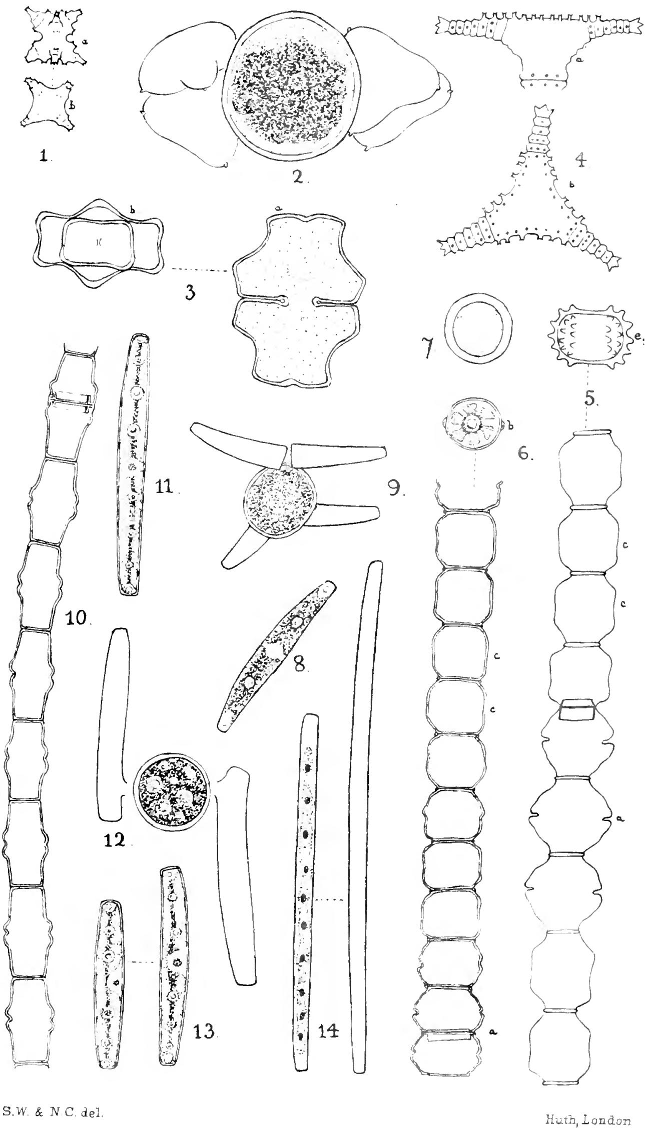

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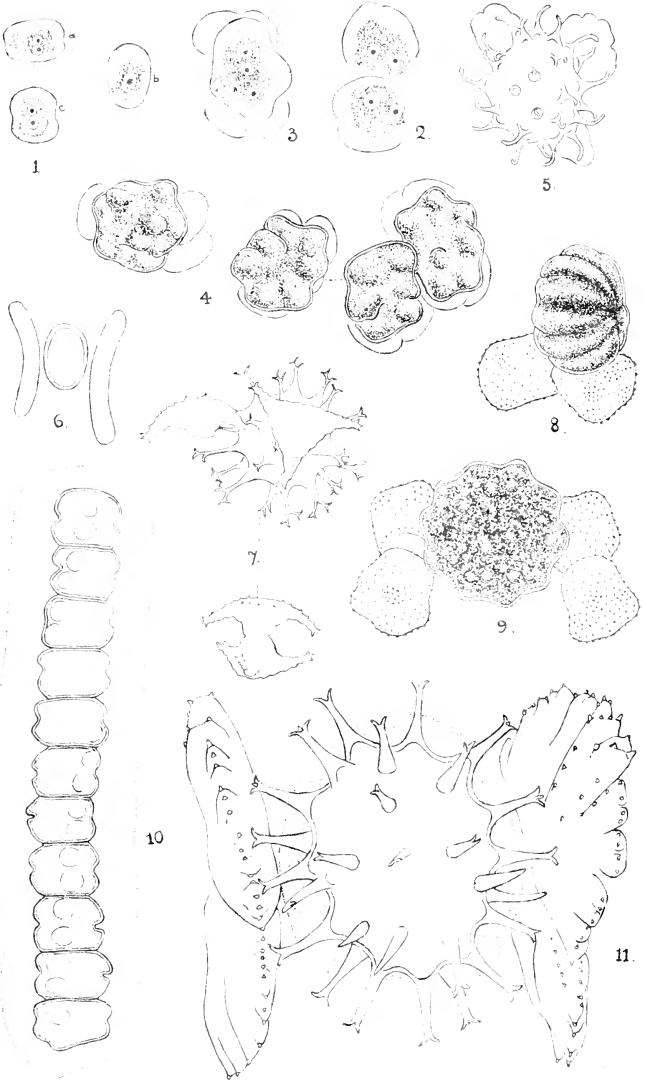

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